

COGNITIVE TEMPO AND NONVERBAL LEARNING
USING THREE TEACHING METHODS
IN APHASIC AND NONAPHASIC ADULTS

By

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To my lifelong friend, Kúlvato

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Sensitivity to cognitive strategies of learning may be equal in importance to selection of tasks in aphasia treatment. The failure to fully describe learning potential in the adult aphasic may be due to an incomplete appreciation for the interaction of treatment methodology and individual cognitive differences. Also, though clinical aphasiologists have shown a growing appreciation for the variety and potency of behavior modification procedures, the efficacy of antecedent and consequent events have not been fully described. Therefore, the purpose of this study was to describe the efficacy of 3 teaching methods relative to cognitive tempo attributes in aphasic adults.

Experimental tasks required a 2-category sorting response to nonverbal (visual) stimuli. Three teaching methods manipulated select parameters of antecedent versus consequent events. The "antecedent" method involved learning through observation of a model. The "consequent" method provided corrective feedback. The "antecedent plus consequent" method included both observation of a model and corrective feedback.

The reflectivity-impulsivity dimensions of cognitive tempo refer to the accuracy and speed with which an individual responds to situations in which several alternative solutions are available simultaneously. The reflective individual's responses are slow and accurate; the impulsive's, fast and inaccurate.

The performances of left brain-damaged aphasic individuals, right brain-damaged nonaphasic and non-brain-damaged subjects (12 in each group) were compared with respect to nonverbal learning, cognitive tempo attributes, language ability, visual abstract reasoning ability, and immediate memory for digits and geometric forms.

The primary findings of this study were as follows. The left brain-damaged subjects were not significantly different from control groups on nonverbal learning by any method or in overall learning proficiency. The left brain-damaged group was significantly poorer than either or both control groups on language scores and immediate memory, but no statistically significant difference occurred among subject groups on visual abstract reasoning. Correlation analyses did not offer support for strong relationships between the nonverbal learning tasks and any of the independent measures.

With respect to cognitive tempo, accuracy and latency data for all subjects were pooled and subjects were then classified as either "reflective," or "impulsive," and the remainder were designated "neither." In the left brain-damaged aphasic group, 5 subjects were classified as reflective; 4, as impulsive. In the right brain-damaged group, 3 subjects were reflective; 8, impulsive. In the non-brain-damaged group, 4 subjects were reflective; and 5, impulsive. No interaction between cognitive style and teaching method occurred

when learning scores for reflectives (all groups combined) were contrasted to impulsive subjects (all groups combined). A more refined analysis revealed a statistically significant interaction between teaching method and cognitive tempo in the reflective aphasic subgroup. For aphasic reflectives, the modelling method was significantly less efficacious than either the corrective feedback or modelling plus feedback approaches. No other cognitive style by method interactions yielded significant differences in nonverbal learning.

The view that task variables should be compatible with learner variables if learning is to be optimized was supported by the findings of this study. Future research should analyze the interaction of cognitive tempo with verbal as well as nonverbal learning using a wider variety of antecedent and consequent event manipulations. Consideration of other cognitive attributes such as central versus incidental learning, convergent versus divergent behavior, problem solving strategies, etc. should be made. A more precise definition of individual cognitive or "process" variables will hopefully lend more precision to the clinician's selection of optimal goals and tasks in aphasia treatment.

CHAPTER 1
INTRODUCTION AND REVIEW OF THE LITERATURE

Introduction

Methodology refers to the principles and practices which clinicians employ as they go about their daily responsibilities of teaching the mental strategies children and adults use to acquire knowledge. The two, methodology and learning, should not be antagonistic modes of operation. (Winitz, 1976)

This statement implies that the strategies of a learner can be influenced by the methods used by the clinician. The compatibility of specified methodologies (external task variables) and mental strategies (internal learner variables) is important to the facilitation of learning behavior. Our understanding of the cognitive sequelae of brain damage is incomplete, particularly as it relates to learning by the adult aphasic individual. Similarly, data supporting the efficacy of various clinical methods designed to facilitate the reacquisition of language are sparse. Thus, two related areas -- teaching methodology and cognitive style -- required further investigation. The primary goals of this study were to describe the relative influence of three types of stimulus presentation on the acquisition of nonverbal rule-governed material by aphasic adults, and to examine the relationships among teaching methodology, learning proficiency, and the reflectivity-impulsivity dimensions of cognitive style. To ferret out the impact of acquired language deficit on cognitive tempo

and on learning proficiency under select stimulus conditions, the performance of left brain-damaged aphasic adults was compared with right brain-damaged and non-brain-damaged adults.

Review of the Literature

The diagnosis of aphasia in an individual is typically accompanied by a label or classification as to type of aphasia. Implicit in traditional classifications, such as Broca's or Wernicke's aphasia, is locus of lesion information. Other classification systems reflect a psycholinguistic bias, a concern for severity, or an emphasis on the relationship of modalities of deficit. The type of aphasia, derived from observed language behavior, presumably has prognostic significance. Concomitant neurogenic deficits (e.g., the agnosias, the apraxias, etc.) affecting language are typically considered in assessing prognosis. Factors unrelated to the neurologic insult (e.g., age, education, duration of aphasia before initiation of treatment, etc.) also have an impact on prognosis for language recovery. The ability and potential of the aphasic individual to learn new material, both nonverbal and verbal, has been somewhat neglected as a potentially valuable prognostic indicator. Carson, Carson and Tikofsky (1968) were among the first to suggest that aphasic individuals might be more accurately classified according to their learning performance rather than by neurological findings or performance on aphasia batteries measuring linguistic skills.

Two types of learning may be of interest to the language pathologist: 1. the learning of a specified corpus of language

forms through rote memorization, or 2. the learning of rules of language whereby the ability to recognize, retain and use language forms is not limited to those specifically taught but is generalizable to similar material. Programming for maximal generalization in treatment may depend on the consideration of at least two general sets of variables. First, the intricate relationships among modalities of language, hierarchies of linguistic complexity, and the automatic versus propositional aspects of language use must be appreciated. Second, individual cognitive variables must be considered. For example, one might ask: is the individual able to perceive similarities and differences among diverse language forms and among situations which demand language use? Can the individual learn through indirect experience (observation), or does he require direct instruction?

Perceptual-cognitive capabilities are necessary to nonverbal rule (or concept) learning. Rule learning involves an individual's ability to perceive regularities in seemingly patternless materials, to organize these materials consistently according to a categorization principle (or rule), and then to generalize the acquired conceptual rule to similar untrained material. Rule learning is distinguished from learning characterized by concrete associations and acquisition of concepts by rote memorization.

The ability of an aphasic individual to learn rule-governed material may be depressed because of an interference with his abstraction and organization skills, according to those who view aphasia as a "process" deficit. In the process model, language is viewed as a form of cognitive behavior, where the term cognition refers to:

. . . all the processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. (Neisser, 1966, p. 4)

Aphasia is defined as a reduction in the efficiency of the action and interaction of those cognitive processes such as memory and problem-solving which support language (Martin, 1975). This model contrasts with the "stimulus-response" model, which suggests that a loss of specific concepts underlies a learning deficit. Adherents to a "process" model focus therapy on the reorganization of an impaired cognitive system, while adherents to a "loss" view emphasize reproduction of language content.

Regardless of whether a clinician is primarily concerned with reorganizing the cognitive processes underlying language or reteaching language content, he cannot ignore the necessity of establishing stimulus control in the clinical setting. A description of how stimulus control is to be developed and maintained must be specified relative to teaching method, task variables, and individual learner aptitudes. Thus, a concern for effective clinical intervention, which implies operationalization of the term "learning," reconciles aphasia clinicians of both theoretical backgrounds.

Intervention Approaches and Facilitation Strategies

The various intervention approaches available to clinical aphasiologists (Schuell, Jenkins and Jimenez-Pabon, 1964); Beyn and Shokhar-Trotskaya, 1966; Wepman, 1972; Holland, 1975; Martin, 1975) and the efficacy of various facilitative and compensatory strategies (LaPointe, 1975, 1977) are presented in the aphasia literature. The choice of an approach to therapeutic intervention is guided by one's

definition of aphasia, i.e., as being a "loss" or an "interference" phenomenon. The choice of a given set of compensatory-facilitative strategies, while guided by one's definition of aphasia, is generally more eclectic and guided by specific needs of the individual patient. In other words, the choice of treatment procedures is guided by a concern for stimulus control. According to LaPointe:

The goals of the clinician in the use of any compensatory-facilitative strategy are: (1) to help the aphasic person compensate for his deficit; and (2) to suggest ways in which responding is possible or less difficult. The options available to the clinician to effect these goals are multi-faceted: he may standardize and simplify task instructions; he may restrict the amount and complexity of stimuli; he may provide a wide variety of prompts and cues; he may manipulate the modality of input and output; or he may manipulate the level of response. (1977, p. 29)

The problem of performance facilitation in aphasic individuals can be resolved, in part, by psycholinguistic considerations (Croskey and Adams, 1969; Parisi and Pizzamiglio, 1970; Shewan and Canter, 1971), as well as by modality considerations (Halpern, 1965; Goodglass, Barton and Kaplan, 1968; LaPointe and Williams, 1971; Gardiner and Brookshire, 1972; LaPointe and Horner, 1976). A variety of other parameters pertinent to speech and language responding by the language-impaired adult include: physical characteristics of stimuli (Benton, Smith and Lang, 1972; Corlew and Nation, 1975); stimulus context (Barton, Maruszewski and Urrea, 1969; Webb and Love, 1974); task difficulty (Brookshire, 1972); intermodality considerations (Weigl and Bierwisch, 1970; Ulatowska and Richardson, 1974; Weigl, 1974); and types of prompts (Berman and Peelle, 1967; McDearmon and Potter, 1975; Whitney, 1975).

This literature has enhanced the aphasiologist's sensitivity to individual programming needs. However, information regarding methodologies applicable to all types of task and stimulus variables, and suitable at any point on a linguistic-nonlinguistic task continuum is needed. For example, the efficacy of an intervention technique or strategy may be related to some general difference in the mode of presentation of material to which the individual learner is presumably predisposed to respond more productively. This predisposition may be related to the specific pathology which rendered the person language and/or learning disordered, or to factors related to premorbid reinforcement history. Specifically, the efficiency of learning by a given individual may be related to how he had learned to respond in the past to the antecedent and consequent conditions which surrounded operant responses. The impact of specified antecedent and consequent events on the learning of nonverbal rule-governed material was investigated in this study.

The Behavioral Equation

The behavioral equation, represented in Figure 1, includes the components of a complete behavioral unit (Sulzer and Mayer, 1972; Wolking, 1974), and is described below.

General setting

General setting refers to the set of conditions which make up the background of the behavior, e.g., where, when, how often, in what sequence, for how long, and light, noise and temperature conditions, etc.

ANTECEDENT
EVENTS

CONSEQUENT
EVENTS

Stimulus
Control

Contingency
Management

General
Setting

Task Signals
and
Discriminative
Stimuli

Response

Schedule
of
Reinforcement

Consequences

FIGURE 1
THE BEHAVIORAL EQUATION
(Wolking, 1974)

(FROM HORNER, 1977)

Task signals and discriminative stimuli

Task signals and discriminative stimuli are the events and variables such as task characteristics, instructions, prompts and cues, which are intended to have a direct influence on the response. The type of stimuli chosen is critical to the goal of establishing stimulus control.

Stimulus control is demonstrated when the stimuli that were present during the modification of an emitted response begin to control the emission of that response. Thus, under stimulus control conditions, the response form or frequency is different under one stimulus, or set of stimuli, than another. These stimuli are referred to as discriminative stimuli. (Sulzer and Mayer, 1972, glossary)

Discriminative stimuli can be precisely described along several parameters, according to Wolking (1974): sense modality, signal form and number, display time, content, and stimulus-response interval.

Response

A response is a voluntary behavior which may be occasioned by general setting and discriminative stimulus characteristics but which is primarily strengthened or weakened by the controlling influence of consequent events (aversive or positive stimuli). The response is the only dependent behavior in the behavioral equation.

Schedule of reinforcement

The schedule of reinforcement is a statement of the rule for presenting or withdrawing the consequent event(s). It describes the contingency between the response and the consequence.

Consequence

The consequence is a stimulus which is contingent upon the occurrence of the emitted response, and may serve to increase,

decrease or maintain the type and/or frequency of a response.

Thus, in the process of establishing stimulus control, the events antecedent to the response -- the general setting, task signals and discriminative stimuli -- are of primary concern. Contingency management, on the other hand, involves choosing a schedule of reinforcement and type of consequent event which will control the form and/or frequency of the emitted response (Sulzer and Mayer, 1972; Wolking, 1974).

Programming Antecedent and Consequent Events

Operant conditioning methodology has been applied with success in aphasia therapy. Programmed instruction for teaching discrimination tasks to aphasic adults has been reported (Filby and Edwards, 1963; Rosenberg and Edwards, 1964; Edwards, 1965; Rosenberg, 1965). Successful modification of language in aphasics using programmed instruction also has been reported (Holland, 1972, 1975). The type of consequent event used in behavior modification programs has been investigated. Kushner, Hubbard and Knox (1973) found three types of punishment to be differentially effective in modifying responses of aphasic patients (time out, response cost, and presentation of aversive stimuli), while the best performance was established through a combination of positive reinforcement and punishment. Brookshire (1971) found performance by aphasic subjects to be particularly sensitive on a probability learning task to delays of reinforcement, while normals were unaffected by such delays. Goodkin (1966, 1969) reported the effective use of a wide variety of consequent events in modifying verbal behavior, e.g., verbal and token feedback, self-reinforcement, and self-punishment.

The emphasis in operant methodology has been on contingency management, i.e., the application of effective consequent events. In recent literature focusing on aphasia treatment, a growing interest in the antecedent event is evident (Hedrick, Christman and Augustine, 1973); Rosenbek, Lemme, Ahern, Harris and Wertz, 1973; Bollinger and Stout, 1976). Greater attention is being given to the variables influencing task difficulty, e.g., sense modality, signal form and content, the type and amount of cueing, and the temporal characteristics of cueing (simultaneous, delayed, successive). The use of task continua (Rosenbek et al., 1973; Bollinger and Stout, 1976) has developed from an emphasis on programming antecedent events. LaPointe stated:

In fact, manipulating the antecedent event, or stimulus control, as it is known in traditional operant terminology, is probably the most potent factor available to the clinician in aphasia therapy. (1977, p. 57)

The rationale for focusing primarily on antecedent events in aphasia therapy is:

. . . the belief that there is a hierarchy of cueing techniques available that vary in their ability to elicit [occasion] the desired response. (1977, p. 57-58)

The elements of the behavioral equation, the importance of stimulus control, and the relative emphasis on consequent and antecedent events in aphasia therapy pertain to the development of experimental stimulus materials and teaching paradigms described below.

Briefly, the learning tasks designed for the present study

involved the acquisition of rules governing the categorization of nonverbal (visual) stimuli. The 3 modes of stimulus presentation, hereafter referred to as "teaching methods," were defined by the presence or absence of antecedent and/or consequent events. A subject's ability to perform within 3 teaching methods may be related to his cognitive style. The importance of the relationship between teaching method and cognitive style, drawn mainly from the learning disabilities literature, is developed in the following section.

Cognitive Style

Process variables important to both learning and to predicting learning success have been described in one area of research as differences in cognitive style. Kagan, Moss and Sigel defined cognitive style as:

. . . stable individual preferences in the mode of perceptual organization and conceptual categorization of the external environment. (1963, p. 74)

Gaines offered the following definition:

Cognitive style can be generally defined as a pattern of orientation to stimulus variables sufficiently consistent to enable some prediction of preferences and learning processes. (1975, p. 984)

Some of the main cognitive style dimensions that have been discussed in the literature include: analytic-relational; field dependence-field independence; reflectivity-impulsivity. The definitions and relationships among these constructs will be briefly reviewed.

Analytic-relational cognitive styles

When a response is made in which a visible element shared by all class members is used as the basis for selecting the group, the response is described as "analytic." When a functional relationship is established among the class members and this relationship becomes the basis for grouping the members, the response is designated "relational." An example of an analytic response is: a watch and a ruler are associated because they both have numbers. An example of a relational response is: a watch and a ruler are associated because they both measure something (Kagan et al., 1963). Two basic cognitive dispositions presumably underlie the analytic-relational cognitive styles: 1. the tendency to differentiate small details in complex visual arrays, a disposition similar to field dependence-independence styles; 2. cognitive tempo, where analytic responding is associated with reflectivity (slow-accurate responding), and relational responding is associated with impulsivity (fast-inaccurate responding).

Field dependence-independence cognitive styles

An analytical, in contrast to a global, way of perceiving entails a tendency to experience items as discrete from their backgrounds, and reflects ability to overcome the influence of an embedding context. People differ in the extent to which their perception is analytical. This dimension of individual differences has been called field dependence-independence. (Witkin, Dyk, Faterson, Goodenough and Karp, 1962, p. 57-58)

Thus, field dependence-independence refers to one's adeptness at isolating figures embedded in complex backgrounds (Davis, 1971, 1976; Campbell, 1973; Nebelkopf and Dreyer, 1973). Field dependence-

independence corresponds to analytic versus relational modes of responding, and impulsive versus reflective tempo differences, respectively.

Cognitive tempo: reflectivity-impulsivity

Cognitive tempo differences in learners are described along the dimension of reflectivity-impulsivity.

Operationally the construct has generally been defined by the length of time required to make a selection among several possible alternatives in a problem-solving task and the accuracy of that selection. Impulsivity refers to the tendency to make fast decisions and many errors, while reflectivity refers to slow decision times with relative accuracy. (Adams, 1972, p. 1076)

Accuracy and speed have been used to operationalize the reflectivity-impulsivity distinction. A refined interpretation of this cognitive tempo construct is offered by Kagan and his associates:

Reflection is defined semantically as the consideration of alternative solution hypotheses (either classifications or problem-solving sequences) when many are available simultaneously. Reflection does not refer to delay that is the result of fear of failure, timidity, or inability to generate a solution. (Kagan, Rosman, Day, Albert and Phillips, 1964, p. 33)

The reflection-impulsivity dimension is concerned with the degree to which the subject reflects on the validity of his solution hypotheses in problems that contain response uncertainty. (Kagan and Kogan, 1970, p. 1309)

Kagan et al. (1964) postulated at least three possible etiological mechanisms for cognitive tempo differences: 1. constitutional factors; 2. involvement in the task; 3. expectation of failure. Two types of anxiety presumably causing cognitive tempo differences are: 1. anxiety over total incompetence in the test situation, which

leads to fast-inaccurate (impulsive) responding; and 2. anxiety at the uncertainty over making an error on a task one believed one could solve, which leads to slow-accurate (reflective) responding. Kagan's Matching Familiar Figures test has become a widely accepted instrument for measuring cognitive tempo (Kagan et al., 1964; Kagan, 1965, 1966a, 1966b; Kagan, Pearson, and Welch, 1966a, 1966b).

In the cognitive literature, researchers have suggested that individual learning styles or preferences can be assessed and lend themselves to predicting learning capabilities with respect to age (Adams, 1972), attention factors (Weiner and Berzonsky, 1975), focusing behavior (Nuessle, 1972), memory and input modalities (Fox, 1974), task requirements (Kagan, 1965; Kagan et al., 1966a; Odom, McIntyre and Neale, 1971).

With respect to task requirements, Kagan (1965) found reflective subjects performed with greater accuracy than impulsives on visual matching tasks (designs and pictures) and word reading tasks. Kagan et al. (1966a) reported that reflective subjects had slower response times and lower error scores on three inductive reasoning tasks than impulsive subjects, even when measures of verbal ability were controlled. On a match-to-sample perceptual task, Odom et al. (1971) found reflective children made fewer errors, required fewer trials to reach criterion and had longer latencies on the training task. On a transfer task, no differences between cognitive tempo groups were discerned.

Of special clinical interest is the finding that cognitive style is amenable to change (Baird and Bee, 1969; Denney, 1972; Zelniker, Jeffrey, Ault and Parson, 1972). Baird and Bee (1969) found that

analytic and nonanalytic responding could be modified by differential reinforcement. Using observational learning (where children observed an adult who modelled a particular cognitive style), Denney (1972) found that both cognitive style (analytic-relational) and cognitive tempo (reflectivity-impulsivity) could be modified. Zelniker et al. (1972) found that the latency and accuracy dimensions of a response could be modified by the type of task presented. A task of differentiating familiar figures ("find the one that is different") was easier for impulsive subjects than a task of matching familiar figures ("find the one that is the same").

The interrelationship of cognitive style and teaching methodology has received some attention in the child development literature (Davis and Klausmeier, 1970; Cooperman, 1974; Montgomery, 1974). Davis and Klausmeier (1970) studied high school age subjects who were identified as high or low analytic responders. The high analytic subjects (comparable to reflectives) performed well on a concept identification task; the low analytic subjects performed poorly. The two training procedures studied were verbalization training (overt verbalization by the learner of the stimulus attributes) and prompt training (presentation of a cue which provided the subject with information concerning the correct response prior to his responding). With training, both groups improved their concept identification performance, but an interaction between cognitive style and either or both training procedures was not found.

Montgomery (1974) studied the effects of feedback and consequentiality on the cognitive dimensions of reflectivity-impulsivity. Three groups were discerned on the basis of pretest accuracy scores:

below average, average, and above average. All groups were given feedback as to their pretest performance, and they were informed of future consequences (in terms of number of recesses to be missed), to be based on posttest performance. Feedback as to pretest accuracy did not affect posttest accuracy for any group, but did cause an increased latency in the original below-average performers. Information on future consequences increased the latency of reflective subjects, while the latency of impulsive subjects was not affected by consequences.

Finally, Cooperman (1974) studied field dependence and children's problem-solving skill under varying contingencies of predetermined feedback on a verbal anagram problem-solving task. This investigator found field independent subjects' performance was less contingent on external sources of approval, in contrast to field-dependent subjects, who did better with positive feedback. Thus, in Cooperman's study, cognitive style interacted with type of feedback.

In summary, Davis and Klausmeier (1970) studied the interaction of two types of antecedent task signal (verbalization and prompt) and cognitive style relative to performance. No interaction was found. The findings of Montgomery (1974) and Cooperman (1974) suggested that the type of feedback may differentially affect learners who manifest differences in cognitive style or tempo. The interaction of cognitive style (learner process variables) and teaching method (task variables) in brain-damaged adults was investigated in the present study.

Verbal and Nonverbal Cognitive Performance in Aphasia

The ability of aphasic individuals to process nonverbal and verbal material is a complex and only partially resolved issue. The research questions in this area include: are the information handling and learning performance deficits in aphasia a concomitant of language deficit, or of the brain damage per se? Is this deficit limited to processing verbal materials (and as such presumably a reflection of the aphasia), or does the deficit extend also to nonverbal materials? Several issues are addressed in order to elucidate these problems.

Lateralization of verbal and nonverbal functions

When an intellectual deficit occurs in the brain-damaged individual, is this manifest as a verbal deficit or as a nonverbal deficit? Signs of intellectual impairment depend on the side of lesion, according to many researchers. The concept of laterality of verbal and nonverbal functions is supported by findings that left (dominant) hemisphere damage is more often associated with loss of verbal ability than right hemisphere damage, which is associated with the loss of nonverbal visuo-spatial skills (Andersen, 1951; Reitan, 1954, 1955; Heilbrun, 1956; Moscovitch, 1976).

Nonverbal cognitive performance in the brain-damaged

Are the psychological processes tapped by nonverbal reasoning tasks limited to the functioning of the right hemisphere? Using the Raven's Progressive Matrices, a nonverbal task requiring processing of visuo-spatial stimuli, Piercy and Smyth (1962) found performance to be worse in patients with right-sided lesions than with left-sided lesions. Costa, Vaughn, Horwitz and Ritter (1969) and Costa (1975) obtained similar results, but felt that disparate

neurologic severity among subject groups and/or variability among sections of Raven's test might have accounted for these differences. Arrigoni and DeRenzi (1964) found performance to be more affected by left-sided lesions. Others have found no difference in performance on Raven's Coloured Progressive Matrices (hereafter RCPM) relative to side of lesion (Costa and Vaughn, 1962; DeRenzi and Faglioni, 1965; Basso, DeRenzi, Faglioni, Scotti and Spinnler, 1973). Similarly, Shontz (1957) and Boone (1959) found no difference between right brain-damaged (hereafter RBD) and left brain-damaged (hereafter LBD) subjects using two nonverbal cognitive tasks, the Columbia Mental Maturity Scale and the Knox Cubes test. These latter studies support the view that brain damage per se is responsible for lowered nonverbal reasoning scores, irrespective of the hemispheric side of lesion.

Nonverbal cognitive performance in aphasic persons

What is the relative contribution of verbal deficits to nonverbal intellectual performance? This question has been studied by comparing LBD aphasic individuals with LBD nonaphasic or RBD nonaphasic controls. Meyers (1948) found no significant differences between aphasic and nonaphasic subjects on a battery of nonverbal tasks of graded difficulty, a finding later confirmed by Bauer and Becka (1954). DeRenzi and Faglioni (1965) found neither the side of lesion, nor the presence of aphasia to be significantly correlated with performance on the RCPM. Boone (1959), Zangwill (1964) and Wertz (1967) also concluded that no significant relationship exists between language impairment and nonverbal intellectual functioning.

The relationship between brain damage and/or aphasia and the

ability to perform nonverbal tasks may be related to the type of task. Modifications of Weigl's Color Form Sorting Task (Weigl, 1941) such as the Shure-Wepman Concept Shift Task (Archibald, Wepman and Jones, 1967) and the Wisconsin Card-Sorting Task (Grant and Berg, 1948; Grant, 1954) have been widely used to assess nonverbal cognitive abilities in brain-damaged populations. This type of cognitive task tests a subject's ability to sort materials according to simple concepts, e.g., color, shape and number, and his ability to shift the basis of his classification from one concept to another. The task taps a subject's ability, first, to perceive the concepts underlying possible sorting responses, and, second, to change the mode of problem solution consequent with a change in the problem (sorting rule), as predetermined by the examiner. (See Appendix D for a description of the Wisconsin Card Sorting Task.)

Weigl (1941) reported brain-damaged subjects were less proficient on a simple color-form sorting task than normal controls. Teuber, Battersby and Bender (1951) tested patients with traumatic cerebral insult and found posterior lesions were associated with greater deficits on a card sorting task than anterior lesions. McFie and Piercy (1952) and later McFie and Zangwill (1960) contested the importance of site of lesion in favor of the hypothesis that hemispheric side of lesion accounted for card-sorting performance deficits. They found significantly more failures associated with left hemisphere lesions than with right hemisphere lesions. Milner (1963) studied patients undergoing surgery for relief of epilepsy and concluded that the ability to shift from one sorting principle to another was represented in the frontal lobes, and not related to side of

lesion. However, in a long-term follow-up study, subjects with left frontal lesions presented more lasting and consistent deficits on the Wisconsin Card-Sorting Task (hereafter WCST) than after right frontal deficits (Ettlinger, Teuber and Milner, 1975). Poppen, Pribram and Robinson (1965), using a multiple choice concept task, concurred with the finding that left frontal lesions result in greater deficits than other lesion sites. Drewe (1974) also found left frontal cases to be most impaired on the WCST in comparison with right frontal and left and right posterior lesions. The left frontals achieved fewer categories and made more perseverative errors than other groups. Using a simplified version of the WCST and a refined analysis of perseverative errors, Nelson (1976) found subjects with frontal lobe lesions performed less well than other groups, and there were no laterality effects in either frontal or posterior subjects. The author observed that the simplification of the task may have minimized possible verbal mediation effects, thereby reducing the role of the left hemisphere.

The impact of linguistic deficit on conceptual tasks remains in question. Some investigators have concluded that the severity of linguistic deficit is related to nonverbal intellectual deficits. For example, Tikofsky and Reynolds (1962, 1963) studied nonverbal learning using a modified WCST in aphasic and normal individuals. Learning rate (number of trials to criterion) was slower in aphasic subjects than in normal subjects. The difference in rate of learning was attributed to the greater proficiency of nonaphasic subjects to generalize task solutions from one sorting task to the next. Both groups showed improved learning rate with practice. Because

nonaphasic brain-damaged controls were not used for comparison, and aphasia was not objectively evaluated in order to ascertain severity, the conclusions of this study were limited. Archibald et al. (1967) found that severe aphasics, as measured by the Language Modalities Test of Aphasia (Wepman and Jones, 1961) were more impaired than mild LBD aphasics and RBD nonaphasic patients on several cognitive tasks. The RCPM and the Shure-Wepman Concept Shift Test were found to be particularly sensitive to severity of aphasia in the study by Archibald et al. (1967). Culton's (1969) findings concurred with this line of research. He documented decreased intellectual functioning, as measured by the RCPM in "recent" aphasics, and found improvement of intellectual functioning concomitant with spontaneous recovery of aphasia. Culton felt these data supported Weisenburg and McBride's (1935) contention that intellectual problems in the aphasic individual are reduced as the aphasia lessens in severity.

Studying LBD aphasics, LBD nonaphasics, and RBD nonaphasics, DeRenzi, Faglioni, Savoiardo and Vignolo (1966) found a Weigl-type task ". . . is not sensitive to the presence of cerebral damage per se while it is highly sensitive to the presence of left (dominant) hemisphere lesions associated with aphasia" (p. 419). The scores obtained for aphasic subjects were highly correlated with an auditory verbal comprehension score, though no difference between types of aphasia was discerned.

Using the Western Aphasia Battery (Kertesz and Poole, 1974), and the RCPM, Kertesz and McCabe (1975) found substantial decrements in intellectual performance by "global," "Wernicke's" and "transcortical sensory" aphasics relative to non-brain-damaged controls. "Anomic,"

"conduction" and "Broca's" aphasic groups did not differ significantly from controls. As in the DeRenzi et al. (1966) study, these authors felt that the severity of comprehension deficits rather than the severity of overall aphasia accounted for the observed relationships.

Wertz (1967), in contrast, found neither the WCST nor a multiple choice problem-solving task to be related to speech and language abilities as measured by the Minnesota Test for Differential Diagnosis of Aphasia (Schuell, 1966). He concluded that a lesion in the frontal lobes restricted the ability of subjects to sort cards on the WCST and similar tasks requiring shifting problem solutions. He studied LBD and RBD patients and NBD individuals. The right or left side of lesion in the pathological subject groups proved to be unrelated to performance deficits.

In a recent study, Kim, Boller, Mack and Vrtunski (1976) contrasted LBD aphasics and RBD individuals on a Concrete Conceptual Task (CCT) and an Abstract Conceptual Task (ACT). The former task used pictures representing concepts such as animals, transportation, furniture, etc., while the latter task used concepts such as size, color, and shape. For both CCT and ACT, three stimuli representing a concept were presented for 10 seconds, then removed. Then, the subject was asked to identify the original three stimuli when presented in an array of six stimuli (three target and three foil items). Performance of the LBD aphasic and RBD groups did not differ significantly on the ACT. On the CCT, however, the aphasics performed significantly less well. Pre-experimental equality of receptive vocabulary of the two groups had been ascertained using the Peabody Picture Vocabulary Test (Dunn, 1959). The authors felt

their finding lent support to the contention that conceptual deficits are associated with language disturbance.

Thus, hypotheses concerning side of cerebral lesion, site of lesion intra-hemispherically, and presence of aphasia have been offered as explanations for depressed nonverbal cognitive performance in brain-damaged individuals. When a conceptual deficit is observed in the aphasic it is difficult to interpret. DeRenzi et al. state:

The evidence pointing to a specific defect of 'abstract thinking' in aphasics may be interpreted as the consequence of a disruption of 'inner language' in these patients; however, an alternative view may be advanced, viz., that the same area subserving linguistic activities in the left hemisphere are also specialized in carrying out intellectual tasks of a symbolic nature. (1966, p. 419)

Despite the ostensibly "nonverbal" nature of Weigl-type classification tasks, an element of internal language manipulation may be required for good performance (Zangwill, 1964); hence, their sensitivity to aphasic disturbance.

A third alternative explanation for performance deficits by brain-damaged individuals on nonverbal reasoning tasks may be found in the research on immediate (short term) memory. The extent to which verbal and/or spatial immediate memory span influence performance on a reasoning task may account for differences in performance by the pathologic groups under investigation. DeRenzi and Nichelli (1975) studied the ability of patients to immediately reproduce strings of items of increasing length for verbal (digits, words, and pictures) and spatial stimuli. Four groups of subjects were tested: LBD aphasics, LBD nonaphasics, RBD nonaphasics, and NBD individuals.

The authors concluded:

The results of this investigation leave no doubt that verbal memory span is directly dependent upon an intact left hemisphere and is not affected by damage to the right hemisphere wherever localized. Yet, they also show that what impairs performance is only the presence of aphasia, since left brain-damaged patients without language disturbances do not differ from right brain-damaged patients, both groups being unimpaired with respect to controls. (1975, p. 351)

Spatial span . . . was significantly affected by a lesion posteriorly located in either hemisphere, but not by aphasia. (1975, p. 353)

Verbal learning

An alternative approach to the question of cognitive performance in aphasic individuals is to investigate verbal learning. In a study comparing verbal and nonverbal learning, Ettlinger and Moffett (1970) found sentence memorization and rhythm memorization in aphasic individuals to be dissimilar, and concluded: ". . . their verbal learning defect can be argued not to reflect a nonspecific disorder of learning extending to all classes of material" (1970, p. 471). Halberstam and Zaretsky (1969), who excluded aphasic patients from their experimental groups, reported on the relationship between aging and brain-damage on verbal paired-associate learning. They found that elderly subjects were slower to respond and required more trials to criterion than younger subjects. No significant differences were found in learning with respect to the brain-damaged or non-brain-damaged status of the subjects. For all groups, learning was related to the level of the associative strength of the items on the tasks.

On a serial verbal learning task described by Tikofsky (1971),

aphasic subjects as a group demonstrated a reduction in both the rate and amount of overall verbal learning. For both aphasic and normal subjects, learning of word lists with high associative content was superior to learning word lists with low associative content. In this study, the author neither matched his subject groups with respect to age, education or socioeconomic status, nor described his aphasic subject group with respect to severity of aphasia.

A series of experiments, involving both verbal and nonverbal tasks were conducted by Carson, Carson and Tikofsky (1968). The tasks measured differences between aphasics and normal control subjects on tasks involving, 1. stimulus uncertainty and response time, 2. rote serial learning, 3. a repeated digit symbol task, and 4. a nonverbal rule learning task requiring classification of non-verbal stimuli. Aphasic subjects learned more slowly (requiring more trials to criterion), required more time to respond as stimulus uncertainty increased, and achieved lower levels of performance overall. On all tasks, however, aphasics were able to improve with practice. For both subject groups, rule learning (of nonverbal stimuli) was found to be superior to rote learning (of verbal stimuli). Once a rule was acquired, aphasics were similar to normals in their ability to transfer to untrained material. However, retention and transfer were limited in aphasic subjects. In this regard, the authors stated:

Providing memory load for learning and number of transfer items are not too great, aphasics can learn and transfer rules constructed from abstract properties. (1968, p. 407)

Thus, according to Carson et al. (1968), rate and overall learning were reduced in aphasic individuals, though performance patterns were similar to normal. While the authors felt there was a degree of language manipulation required for nonverbal classification (or rule learning) tasks, and that learning performance bore a relationship to aphasia, their failure to test appropriate control groups or describe the severity of aphasia precluded a definitive resolution of these issues.

The importance of evaluating residual nonverbal and verbal conceptual abilities in aphasic individuals relates to the clinical imperative of defining the potential capacity for linguistic operations which these individuals might possess, according to Glass, Gazzaniga and Premack (1973). These authors reported that the capacity for symbolization may be spared even in the most profoundly impaired aphasics. They taught seven "global" aphasics to use an artificial language originally developed for the chimpanzee (Premack, 1971). Using visual-symbols, the aphasics were taught to communicate receptively and productively the concepts of agent, action, object, negative and same-different. Despite severe linguistic limitations, the aphasics were found to be capable of new symbolic learning that was effective for rudimentary communication. During pretesting, all subjects were able to perform a pictorial sorting task involving concepts such as animate versus inanimate, animal versus plant, human versus animal, etc. The ability to visually discriminate salient features and to abstract the underlying concept was a prerequisite, the authors hypothesized, to successful sorting. The ability to perform such perceptual-cognitive operations may be

prerequisite to artificial language acquisition and use. The authors speculated as to the possible participation of the nondominant hemisphere in this learning process.

Statement of the Problem

Aphasiologists have shown an increasing appreciation for the potency of manipulating antecedent and consequent events in programmed therapy. However, the relative efficacy of antecedent, consequent, and antecedent-plus-consequent teaching methods has not been systematically investigated. Modelling and/or providing corrective feedback to the learner are select aspects of the teaching setting which may differentially affect learning. The modelling approach provides a setting for observational learning, while the corrective feedback approach requires more of a trial and error type of response. While the variety and power of antecedent and consequent events extend well beyond the manipulations selected for this study, it was felt that the antecedent versus consequent distinction is a general and valid construct for investigating teaching method differences. An appreciation for these differences has the potential to enhance aphasia treatment programming.

The ability of an aphasic individual to analyze complex stimuli and to learn the relevant distinctive differences among these stimuli may be related to his cognitive style of learning. Accuracy and response time have been used to describe the cognitive dimensions of "reflectivity" and "impulsivity." The tendency for a given person to respond reflectively or impulsively may be influenced, in part, by

the teaching methodology. Or cognitive style may govern learning proficiency irrespective of the method used. An understanding of the interaction between cognitive style and teaching methodology may help the aphasia clinician maximize clinical intervention techniques.

The ability of an aphasic individual to learn appears to have some relationship to the presence of brain damage per se as well as to other possible concomitants, e.g., severity of aphasia, nonverbal intellectual performance, and immediate memory. In order to determine the relative influence of these parameters on cognitive style differences and on learning performance differences within three teaching methods, appropriate comparison groups and independent measures of language, abstract reasoning and memory were necessary. A resolution of the impact of these variables on new learning may offer new insights into the prognosis for recovery of communication abilities in individuals with aphasia.

Statement of the Purpose

The purpose of this study was to answer the following questions:

1. What is the relative efficacy of method of task presentation on the nonverbal rule learning of left brain-damaged aphasic adults in contrast to right brain-damaged nonaphasic adults and non-brain-damaged adults using three teaching methods which systematically manipulate select parameters of antecedent and consequent events?
2. Is learning performance on nonverbal categorization tasks within the three teaching methods systematically related to the

following cognitive or linguistic behaviors: a. cognitive tempo (reflectivity-impulsivity), as measured by the Matching Familiar Figures test (Kagan et al., 1964); b. level of language performance, as measured by the Porch Index of Communicative Ability (Porch, 1967); c. abstract visual reasoning ability, as measured by Raven's Coloured Progressive Matrices (Raven, 1965); and d. immediate memory span for digits and geometric forms?

CHAPTER 2 METHODS AND PROCEDURES

Subjects

Experimental Group

Twelve adult males with aphasia following left hemisphere damage of cerebrovascular etiology and at least one month post onset of neurologic insult comprised the experimental group. Neurologic status was obtained from the medical history. See Table 1 for subject group composition with respect to age, years of education, months post onset, presence of visual field defect, handedness, etiology, and presence of physical deficit. At the time of testing, all subjects were being seen for speech and language treatment, either on an inpatient or outpatient basis by Audiology-Speech Pathology, Rehabilitation Medicine Service, Veterans Administration Hospital, Fort Howard, Maryland. Prior to inclusion in this study, all subjects had been diagnosed as aphasic as determined by performance on the Aphasia Language Performance Scales (Keenan and Brassell, 1972) and the clinical interpretation of a certified speech pathologist. The definition of aphasia adopted in this study was:

Aphasia is an acquired deficit of language following acute insult involving the dominant cerebral hemisphere. Aphasia involves a multi-modality reduction in verbal-symbolic operations which results in inefficient interpretation and formulation of linguistic messages. In the

individual diagnosed primarily as aphasic, the various linguistic systems (semantic, morpho-syntactic, phonologic) are disturbed in disproportion to other neurogenic deficits with which it may coexist, e.g., sensorimotor deficits involving speech (the dysarthrias), motor programming deficits (the apraxias), visual and auditory perceptual deficits (the agnosias), information processing disturbances (involving memory and cybernetic functions) and/or nonverbal intellectual disturbance.

Control Groups

The first control group was comprised of twelve adult males with a medical diagnosis of right hemisphere damage of cerebrovascular etiology at least one month post onset of neurologic insult. See Table 2 for subject group composition with respect to age, years of education, months post onset, handedness, presence of a visual field defect, and physical deficit. Prior to testing, no subject in this pathologic group had presented aphasia as determined by performance on the Aphasia Language Performance Scales and confirmed by the interpretation of a certified speech pathologist. Several subjects had previously received therapy for remediation of dysarthria at the Audiology-Speech Pathology clinic, Veterans Administration Hospital, Fort Howard, Maryland, but no individual was enrolled in therapy at the time of inclusion in this study.

The second control group was comprised of twelve adult male veterans with no history of central neurologic pathology, and no reported history of speech or language problems. See Table 3 for subject group composition with respect to age, years of education and handedness. At the time of testing, subjects were inpatients at the Veterans Administration Hospital, Fort Howard, Maryland, for treatment of arthritis or orthopedic problems.

TABLE 1
PERTINENT DATA FOR LEFT BRAIN-DAMAGED SUBJECTS

SUB- JECT #	AGE	EDUCA- TION	MONTHS POST ONSET	VISUAL FIELD DEFECT	HANDED- NESS	ETIOLOGY ^a	PHYSI- CAL DEFECT ^b
1	46	19	5	yes	R	T	2
2	56	11	23	no	R	E	2
3	52	11	3	no	R	E	1
4	56	12	7	no	R	E	3
5	48	12	29	no	R	E	2
6	54	9	29	no	R	E	3
7	60	10	10	yes	R	T	3
8	57	12	15	no	R	T	2
9	58	14	33	no	R	T	3
10	53	13	4	no	R	T	2
11	59	11	3	no	R	T	3
12	50	12	52	no	R	T	1
<hr/>							
Range	46- 60	9- 19	3- 52				
Mean	54.1	12.2	17.8				

^aEtiology: T = thrombosis; E = embolism.

^bPhysical Defect: All subjects presented right-sided weakness; 1 = wheelchair bound; 2 = ambulatory with a cane; 3 = ambulatory without a cane (at the time of testing).

TABLE 2
PERTINENT DATA FOR RIGHT BRAIN-DAMAGED SUBJECTS

SUB- JECT #	AGE	EDUCA- TION	MONTHS POST ONSET	VISUAL FIELD DEFECT	HANDED- NESS	PHYSI- CAL DEFECT ^a
1	65	20	7	no	R	1
2	66	12	5	no	R	1
3	58	7	19	yes	R	2
4	45	9	21	yes	R	3
5	52	11	96	no	R	3
6	50	8	3	no	R	3
7	60	12	6	yes	R	1
8	70	9	2	no	R	1
9	55	12	14	no	R	2
10	60	8	22	yes	A ^b	2
11	65	12	1	no	R	1
12	55	12	3	no	R	1
Range	50- 70	7- 20	1- 96			
Mean	58.4	11.0	16.6			

^aPhysical Defect: All subjects presented left-sided weakness; 1 = wheelchair bound; 2 = ambulatory with a cane; 3 = ambulatory without a cane (at time of testing).

^bA = ambidextrous; right-handed for writing.

TABLE 3
PERTINENT DATA FOR NON-BRAIN-DAMAGED SUBJECTS

SUBJECT #	AGE	EDUCATION	HANDEDNESS
1	50	6	L
2	66	9	R
3	72	11	R
4	53	12	R
5	80	12	R
6	43	12	R
7	52	8	R
8	49	7	R
9	58	11	R
10	52	9	L
11	54	7	R
12	46	12	R
Range	43-80	6-12	
Mean	56.3	9.7	

Materials

Concept Teaching

The theory of concept teaching as described by Becker, Engelmann and Thomas (1971) was the basis for construction of experimental learning tasks used in this study. Six principles of concept teaching pertinent to construction of experimental tasks are described below.

First, the teaching set differs from the set of all concept instances (see Figure 2).

Second, a generalization set (or response set) is drawn from instances of the set of all concept instances, exclusive of teaching set instances (see Figure 2).

Third, the differentiation of teaching set from generalization (response) set allows one to test behaviorally whether or not a concept has been learned. The operational definition of concept learning is:

A concept has been taught when any or all members of the concept set are correctly identified (responded to in the same way), even though some were not in the teaching set, and any or all not-members of the concept set are responded to in a different way. (Becker et al., 1971, p. 238)

Fourth, consistent with this definition of concept learning, the following definition of "rule" learning was used for the present study. A rule is learned when responses become differentiated in accordance with a regularity in stimuli. A predictable correct two-category sorting response is evidence that the subject has discerned the relevant characteristics of rule-instances from an

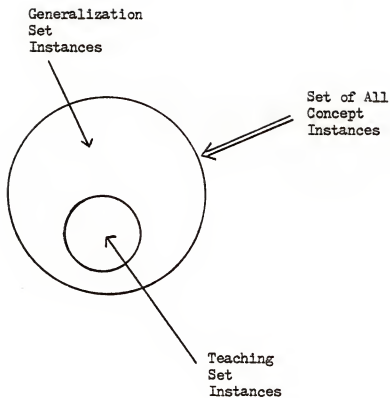


FIGURE 2
DIFFERENTIATION OF LEARNING SETS
IN CONCEPT TEACHING
(Becker et al., 1971)

array of stimuli in which relevant characteristics of not-instances and irrelevant characteristics compete. A definitive test for rule learning is the ability of the learner to transfer the perceived regularity (rule) from stimuli presented for teaching purposes to response stimuli.

Fifth, concept (rule) learning involves a double discrimination: a. the discrimination of relevant characteristics of instances from relevant characteristics of not-instances; b. the discrimination of relevant from irrelevant characteristics within instances or not-instances (Becker et al., 1971, p. 241).

Finally, by way of example, the concept of "squareness" is described in Table 4 and illustrated in Figure 3.

Experimental Tasks

Following concept teaching rationale, nonverbal categorization tasks were constructed.

Four shapes were selected: two angular (rectangle and diamond), and two nonangular (oblong and clover). The general shapes (area covered) were comparable for the rectangle and oblong, and for the diamond and clover. Using a 4 by 4 matrix, 16 possible pairs of shapes were possible (see Figure 4).

Three features were then selected: 1. size ("small" versus "large"); 2. shading ("plain" versus "dotted"); 3. border ("single" versus "double").

In the next step of materials construction, each feature was systematically combined with the core set of 16 shape-pairs, yielding 8 types of stimuli (see Table 5). In the master set of 128

TABLE 4
CONCEPT: SQUARENESS

	INSTANCES	NOT-INSTANCES
RELEVANT CHARACTER- ISTICS	Closed geometric figures with: a. 90-degree angle <u>and</u> b. equal length sides <u>and</u> c. straight sides	Closed geometric figures with: a. any other angle <u>or</u> b. unequal sides <u>or</u> c. curved lines
IRRELEVANT CHARACTER- ISTICS	a. size b. surface texture c. position, etc.	

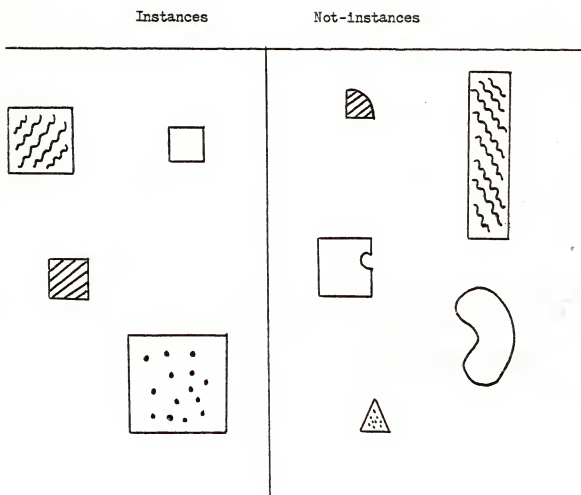


FIGURE 3
CONCEPT: "SQUARENESS"

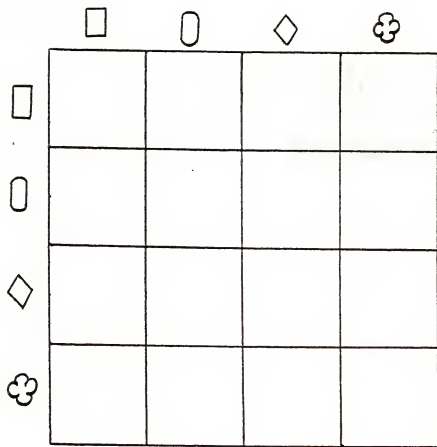


FIGURE 4
FOUR-BY-FOUR MATRIX SHOWING
SIXTEEN SHAPE COMBINATIONS IN
EXPERIMENTAL STIMULI

stimuli (16 shape-pairs for 8 types), all feature types (size, shading border) and hence each feature subtype ("small"- "large;" "plain"- "dotted;" "single"- "double") are equally represented. In Table 5, the rows represent actual stimulus characteristics. For example, for type 2, the 16 possible shape-pairs are "small," "dotted," and have a "single" border. For type 7, the 16 possible shape-pairs are "large," shading is "plain," and figures have a "double" border. Appendix A specifies the complete set of experimental stimuli.

Concept rules were then formalized (see Tables 6, 7 and 8). Each concept rule represents a sorting or categorization rule. The three concept rules, considered together, reflect the fact that the same set of stimuli can be categorized according to three possible feature distinctions, i.e., size, shading, and border. The rule to be learned is established by the examiner on the initial sort. When a specific rule is selected for learning, e.g., size ("small" versus "large"), the other characteristics represent irrelevant stimuli.

From the core set of 128 stimuli, 40 exemplars were chosen as teaching set instances. To make this selection, stimuli were numbered as indicated in Appendix A and a random selection without replacement procedure was used. Because it was necessary that each stimulus type be represented equally, 5 exemplars were chosen from each of the 8 types. Eight stimuli were randomly eliminated from the remaining 88 stimuli, yielding the 80 stimuli necessary for the generalization set.

The order of stimuli, for both teaching and generalization sets was established through random (without replacement) selection (see Appendix B).

TABLE 6
RULE I: SIZE

	INSTANCE	NOT-INSTANCE
RELEVANT CHARACTER- ISTICS	"small"	"large"
IRRELEVANT CHARACTER- ISTICS	Shape-pairs (16 possible) Shading ("plain" or "dotted") Border ("single" or "double")	

TABLE 7
RULE II: SHADING

	INSTANCE	NOT-INSTANCE
RELEVANT CHARACTER- ISTICS	"plain"	"dotted"
IRRELEVANT CHARACTER- ISTICS	Shape-pairs (16 possible) Size ("small" or "large") Border ("single" or "double")	

TABLE 8
RULE III: BORDER

	INSTANCE	NOT-INSTANCE
RELEVANT CHARACTER- ISTICS	"single"	"double"
IRRELEVANT CHARACTER- ISTICS	Shape-pairs (16 possible) Size ("small" or "large") Shading ("plain" or "dotted")	

TABLE 9
PRACTICE TASK RULE: SHAPE

	INSTANCE	NOT-INSTANCE
RELEVANT CHARACTER- ISTICS	"star"	"circle"
IRRELEVANT CHARACTER- ISTICS	Size (large or small) Number (1 or 2) Shading (plain or solid)	

The goal in constructing and arranging stimuli was to eliminate the possibility of rote learning. First, the size of the original stimulus corpus (128 stimuli) was sufficient to allow no overlap or repetition of any one stimulus within or between sets. Second, the specification of rules (instances versus noninstances) and the systematic incorporation of relevant and irrelevant cues into the stimuli ensured that the categorical response made by subjects in this study would not be simply a visual recognition (matching) procedure, but would require a selective response to certain distinctive characteristics of the materials.

Cards used to initiate sorting, designated "starter" cards are illustrated in Figure 5. These cards were selected to be interchangeable depending on the rule to be learned, as shown in Figure 6.

A practice task was also constructed. This task represented the rule "shape" (see Table 9). Two starter cards and a corpus of 20 stimuli were constructed (see Appendix C).

All stimuli were then drawn on 5" x 7" plain white index cards, using black ink marker pens.

Procedures

Presentation of Tasks

Practice task

A practice task was used at the beginning of the first experimental session to: 1. screen patients for their ability to do the task as instructed, and 2. allow adaptation to the novel task setting. The arrangement of experimental materials and seating

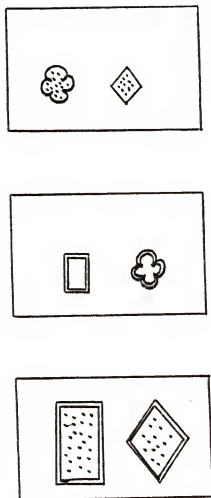
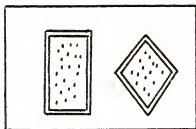
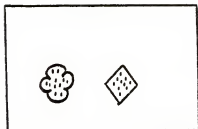
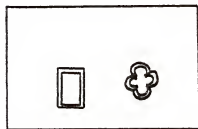
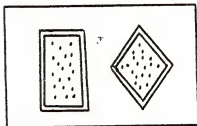


FIGURE 5
STARTER CARDS FOR EXPERIMENTAL TASKS

Task I: Size



Task II: Shading



Task III: Border

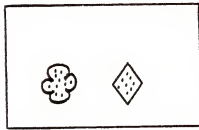
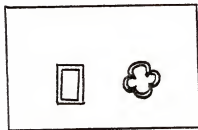


FIGURE 6
STARTER CARDS FOR TASKS I, II, III

of examiner and subject are shown in Figure 7.

Standard instructions pertaining to the practice task and to experimental tasks were presented at this time. Emphasis and gesture were used when appropriate. Repetitions were freely given if the patient indicated he did not understand. The examiner stated:

I am interested in how well you can learn something new.

We are going to do four tasks; the first one is for practice.

I will show you two cards, like these (place starter cards to the subject's left then to his right).

Then I will show you more cards, one at a time, like this (present first card midline and above the starter cards).

Look at this one and try to figure out if it goes here... or here.

For the practice task, the examiner modelled two correct categorization responses and then elicited two pointing responses from the subject; modelled two responses then elicited two pointing responses, etc., until ten correct subject responses were made. On the model, the examiner moved the stimulus card directly above the starter card of choice, while simultaneously pointing to the starter card. Similarly, when the subject responded by pointing, the examiner confirmed the accuracy of his response by moving the stimulus card from midline to just above the correct starter card. If the subject made an inaccurate response, the examiner would move the stimulus card directly above the correct starter card, thereby contradicting the patient's choice. This gestural corrective feedback by the examiner was accompanied by verbal expression of affirmation (yes, it goes here; good; okay, etc.) or denial (no, it goes here, etc.)

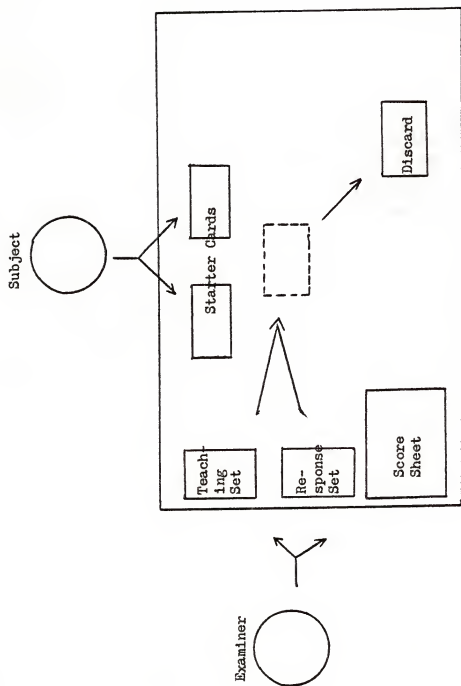


FIGURE 7
ARRANGEMENT OF STIMULUS MATERIALS

with appropriate intonation and gesture. This interchanging of antecedent and consequent information was done on a ratio of 2 antecedent models to 2 subject responses followed by corrective feedback during the practice task in order to minimize a bias to teaching methodology on subsequent experimental tasks. The ease of the practice task was immediately obvious. Subjects began to respond simultaneously with the examiner's sorting model. These simultaneous responses, when accurate, were counted as subject response trials, and reinforced as such. No subject in any group required more than a total of 20 stimulus presentations to acquire the shape ("circle" versus "star") rule. During the practice task, the examiner noted the subject's ability to attend to the stimuli, to respond to the arrangement and number of stimulus items, and to achieve a pointing response.

Experimental Methods

Three experimental teaching methods were defined by the presence or absence of antecedent and/or consequent events.

Antecedent method (Method A)

The application of an antecedent event in the absence of a specific consequence was operationally defined as 10 models of a correct categorization response by the examiner followed by 10 response trials by the subject. The ratio of 10:10 was maintained throughout Method A until the subject achieved 10 consecutive correct responses, or until a predetermined maximum number of trials (30) was reached.

Consequent method (Method C)

The use of a consequent event in the absence of an antecedent model comprised the second experimental teaching method. The subject was instructed to guess, after which the examiner immediately provided corrective feedback. The procedure was continued until the subject achieved 10 consecutive correct responses or until the maximum number of 80 trials was attempted.

Antecedent-plus-consequent method (Method AC)

In the third experimental teaching method, procedures described for Method A and Method C were combined. First, the examiner modelled 10 correct categorization responses. Then, the subject responded for 10 trials. Following each response by the subject, the examiner provided corrective feedback. This model-plus-feedback procedure was followed until the subject demonstrated correct sorting of 10 consecutive cards, or until 80 trials were attempted.

The experimental tasks were presented immediately after the practice task. Prior to each experimental task, the examiner told the subject:

This is task 2 (3, 4). This task is different from the one you just did. But, like before, you must decide which cards go here . . . and which cards go here.

Method A:

This time I want you to watch me. Try to figure out where the cards go by watching me. Then I'll give you a try.

Method C:

This time I will show you the card and you must guess where it goes. At first you must guess and I'll tell you if you're right or wrong.

Scoring

Scoring was made using a plus-minus notation, from 1 to a maximum of 80 trials. A trial was operationally defined as one exposure of the patient to a task card, from either 1. the teaching set (i.e., a card used by the examiner to model a correct response), or 2. the response set (i.e., a card to which the subject responded by making a pointing/categorization response). The criterion for successful acquisition of a categorization rule was set at 10 consecutive response trials by the subject. A maximum number of total trials (modelling by the examiner and/or responding by the subject) was set at 80 trials. Trials were differentiated as teaching set trials or response set trials as shown in Table 10. When stimuli from both stimulus sets were used (in Methods A and AC), they were always alternated in sets of 10. The raw score was figured by subtracting 10 from the ceiling (criterion) response. See Figures 8 and 9 for sample score sheets. If the maximum trials were used without reaching criterion, i.e., when learning of the rule was not demonstrated, a score of 80 was assigned. Hence, a low raw score (e.g., 20) reflects better learning performance than a high raw score (e.g., 44), while the maximum score (80) reflects failure to attain the rule.

Order of Presentation of All Tasks

Three sessions were scheduled for all subjects, and experimental and independent measures were presented as follows.

Session 1

Approximate time: 25-50 minutes.

TABLE 10
DISTRIBUTION OF TRIALS
ACCORDING TO METHOD OF PRESENTATION

	METHOD		
	A	C	AC
Teaching Set (<u>E</u> models)	40	0	40
Generalization Set (<u>S</u> points)	40	80	40
Criterion (consecutive correct response trials)	10	10	10
Maximum Trials	80	80	80

Trials	model		response		model		response		model		response	
	model	response	model	response	model	response	model	response	model	response	model	response
1.												
2.												
3.												
4.												
5.												
6.												
7.												
8.												
9.												
10.												

S # _____

Task Order _____

Method Order _____

Score _____

FIGURE 8
SAMPLE SCORE SHEET: METHOD A OR AC

Trials	response →								
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									
9.									
10.									

S # _____

Task Order _____

Method Order _____

Score _____

FIGURE 9
SAMPLE SCORE SHEET: METHOD C

1. Practice task.
2. Experimental tasks: each subject was exposed to each task (I. Size; II. Shading; III. Border) and each method (Method A; Method C; Method AC) according to the counterbalancing schedule shown in Table 11.

Session 2

Approximate time: 20-35 minutes.

3. Matching Familiar Figures.
4. Raven's Coloured Progressive Matrices.
5. Immediate memory tasks.

Session 3

Approximate time: 45-80 minutes.

6. Porch Index of Communicative Ability.

Approximate total time for all tasks ranged from 2 hours 10 minutes to 2 hours 45 minutes for brain-damaged subjects, in contrast to 1 hour 25 minutes to 2 hours for non-brain-damaged subjects. All pathologic subjects were seen for 3 sessions, while for several normal subjects, sessions 1 and 2 were combined. The sequence of tasks was standard with the following exception. When LBD or RBD subjects had been evaluated using Raven's Coloured Progressive Matrices or the Porch Index of Communicative Ability within 2 weeks prior to inclusion in this study, they were not retested on these measures.

Independent Measures

The Matching Familiar Figures test (children's version), devised by Kagan et al. (1964), was used in this study (hereafter referred to

TABLE 11
COUNTERBALANCED ORDER OF TASK
AND METHOD PRESENTATION

ORDER	TASKS			METHODS		
1	I	II	III	A	C	AC
2	I	II	III	C	AC	A
3	I	II	III	AC	A	C
4	II	III	I	C	A	AC
5	II	III	I	A	AC	C
6	II	III	I	AC	C	A
7	III	I	II	A	C	AC
8	III	I	II	C	AC	A
9	III	I	II	AC	A	C
10	II	I	III	C	A	AC
11	II	I	III	A	AC	C
12	II	I	III	AC	C	A

as MFT). This is a 12-item visual matching task designed to assess the reflectivity-impulsivity dimensions of cognitive tempo.

The test format involves simultaneous presentation of a familiar figure (for example, a boat, a pair of scissors, a telephone) with . . . six . . . facsimiles differing in one or more details. On each of the test's 12 items, the subject is asked to select from the alternatives the one that exactly matches the standard. (Messer, 1976, p. 696)

Stimuli are black and white line drawings (see example of response display in Figure 10), presented on 8" x 10" laminated sheets. A spiral booklet arrangement allowed the stimulus picture to be presented at right angles to the response display. Two practice trials were given and the subject was instructed to point to the picture on the bottom that matched the picture shown in isolation above. After two practice items, the subject was told:

Now we will try some that are a little harder . . .

After you choose, I'll tell you if you're right or wrong;
if you're wrong, you may try again and again until
you find the right picture.

Accuracy on the first response was recorded. The patient was then allowed up to 6 responses to achieve a problem solution. According to standard protocol, latency to the first response, to the nearest tenth of a second, was recorded. The patient was not told that his responses were timed, and the stopwatch was held behind the stimulus booklet to minimize distraction. The response record sheet used for the MFT is shown in Figure 11.

Raven's Coloured Progressive Matrices (Raven, 1965) consists of 36 items wherein designs of varying visual complexity are

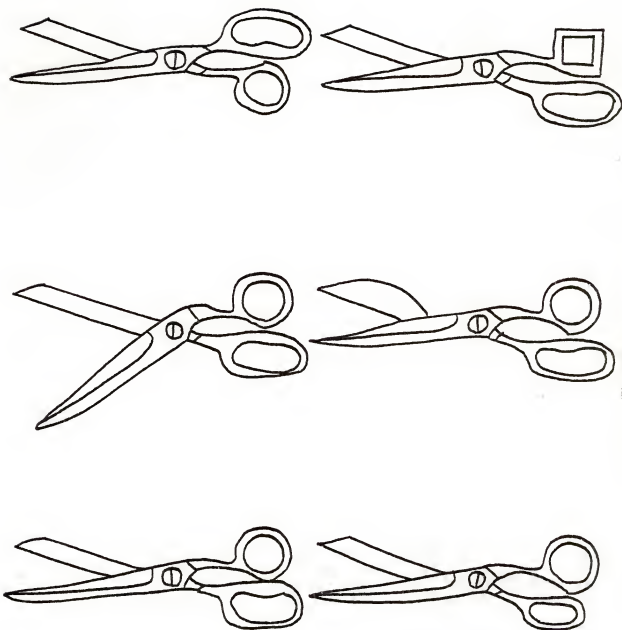


FIGURE 10
MFF SAMPLE RESPONSE DISPLAY

Stimulus		Trials						Time
		1	2	3	4	5	6	
1. house	(1)							
2. scissors	(6)							
3. phone	(3)							
4. bear	(1)							
5. tree	(2)							
6. leaf	(6)							
7. cat	(3)							
8. dress	(5)							
9. giraffe	(4)							
10. lamp	(5)							
11. boat	(2)							
12. cowboy	(4)							

Total Accurate, First Trial:

Ave. Latency:

Total Trials:

FIGURE 11
MATCHING FAMILIAR FIGURES
RESPONSE RECORD SHEET

are presented. Each design has a missing part and the subject must choose from an array of six patterns, the appropriate design completion. This task presumably taps visual abstract reasoning abilities. Some of the skills involved include visual discrimination, spatial orientation, perception of part-whole relationships and analogic reasoning.

Immediate memory for digits and geometric forms was also tested. Figure 12 shows the stimuli and response record form. Digits were presented auditorily and visually, while only visual memory for geometric forms was assessed. On all sections, the subject responded by pointing to a visual display. See Figures 13 and 14 for response displays.

The Porch Index of Communicative Ability (PICA), devised by Porch (1967), is an aphasia battery consisting of 18 subtests. Each subtest consists of 10 items, for a total of 180 responses. Each response was scored on a 16-point multidimensional scoring scale reflecting accuracy, responsiveness, completeness, promptness and efficiency. The mean scores obtained for Gestural, Verbal and Graphic response modalities (8, 4, and 6 subtests, respectively) were the basis for group comparisons. The mean scores for all subtests combined provided an overall mean score. This overall score was presumed to measure degree of communicative ability. While the PICA is used clinically primarily as an aphasia battery, the presence of visual and auditory acuity deficits, premorbid educational status, as well as a range of neurogenic sensorimotor deficits coexisting with aphasia may reflect in depressed scores. Thus, while depressed scores on the PICA do not necessarily represent

IMMEDIATE MEMORY - DIGITS & FORMS
 Audiology & Speech Pathology
 VA Hospital, Gainesville, FL

Name _____
 Date _____
 Examiner _____

DIGITS: Auditory - Visual

___ 1. 5
 ___ 2. 8-1
 ___ 3. 9-4-7
 ___ 4. 6-4-3-9
 ___ 5. 4-2-7-4-1
 ___ 6. 6-1-9-4-7-3
 ___ 7. 5-9-1-7-4-2-3

___ 1. 3
 ___ 2. 9-2
 ___ 3. 1-7-3
 ___ 4. 7-2-8-6
 ___ 5. 7-5-8-3-6
 ___ 6. 3-9-2-4-8-7
 ___ 7. 4-1-7-9-3-8-6

DIGITS: Visual - Visual

___ 1. 8
 ___ 2. 1-7
 ___ 3. 9-6-5
 ___ 4. 3-2-7-9
 ___ 5. 1-5-2-8-6
 ___ 6. 5-3-9-4-1-8
 ___ 7. 6-5-3-9-2-8-1

___ 1. 4
 ___ 2. 3-9
 ___ 3. 2-1-8
 ___ 4. 4-9-6-8
 ___ 5. 6-1-8-4-3
 ___ 6. 7-2-4-8-6-5
 ___ 7. 8-3-1-9-7-2-4

GEOMETRIC FORMS: Visual - Visual

___ 1. ★
 ___ 2. ○ ⊕
 ___ 3. △ ⊕ ⊞
 ___ 4. ○ △ ⊕ ⊞
 ___ 5. ⊕ ○ ⊕ ⊞
 ___ 6. ★ ⊕ ⊞ ⊕ ○
 ___ 7. ⊕ ○ ⊞ ★ ⊞ ⊕ △

___ 1. ○
 ___ 2. ⊕ ⊕
 ___ 3. ○ ★ ⊞
 ___ 4. ⊕ ○ ★ ⊞
 ___ 5. △ ⊕ ⊕ ⊕ ⊞
 ___ 6. ⊕ ⊕ ★ ⊞ ⊕ ⊞
 ___ 7. ⊕ ★ ⊕ ⊞ ○ ⊞ ⊕

FIGURE 12
 IMMEDIATE MEMORY RESPONSE RECORD FORM

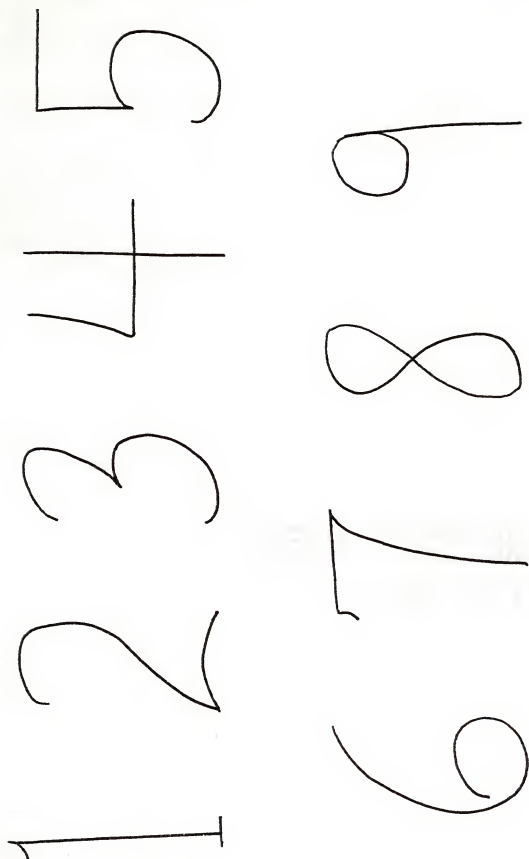


FIGURE 13
MEMORY FOR DIGITS RESPONSE DISPLAY

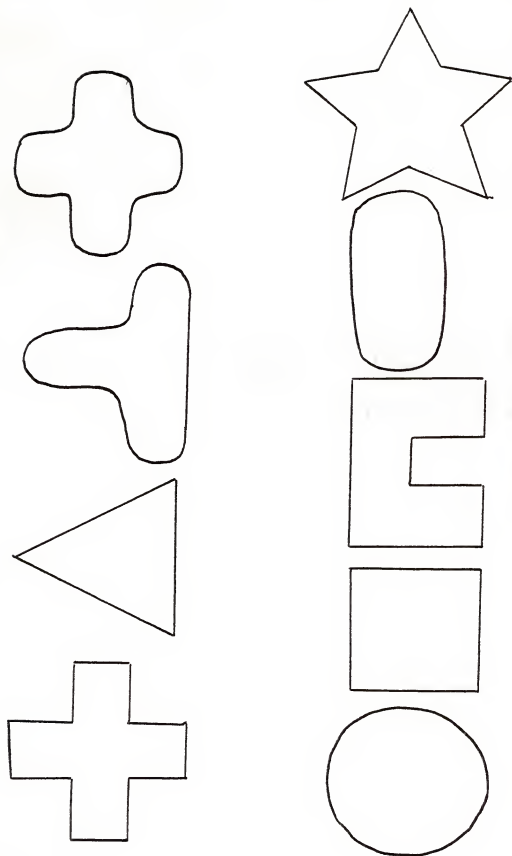


FIGURE 14
MEMORY FOR FORMS RESPONSE DISPLAY

aphasia, the wide range of language and language-related behaviors measured and the standard administration procedures made it the most desirable tool for evaluating and comparing the relative communicative status among groups in this study.

CHAPTER 3 RESULTS

Group Comparisons

Nonverbal Learning

The experimental and two control groups were compared for proficiency of learning the experimental nonverbal categorization tasks. The scores used for comparisons were derived from learning rate (number of trials) using the antecedent method (A), the consequent method (C), and the antecedent-plus-consequent method (AC), and the scores for all methods combined (CLS). Tables 12, 13, and 14 show raw data for learning performance by each teaching method for LBD aphasic subjects (numbers 1-1 through 1-12), RBD nonaphasic subjects (numbers 2-1 through 2-12), and NBD subjects (numbers 3-1 through 3-12). Table 15 contrasts range, median and mean scores obtained under the various teaching methods. A one-way analysis of variance (ANOVA) was performed to compare the three groups. The results of this test were not statistically significant, yielding the conclusion that the groups did not differ in the ability to learn nonverbal categorization rules under methods A, C and AC, or in overall learning proficiency.

The scores for performance by teaching method were derived from learning of Task I (size), Task II (shading) and Task III (border). As mentioned above, the counterbalancing of methods and tasks

TABLE 12
NONVERBAL LEARNING SCORES
ACHIEVED BY LEFT BRAIN-DAMAGED SUBJECTS

Subject	METHOD ^a			CLS ^b
	A	C	AC	
1-1	80	1	10	91
1-2	80	80	10	166
1-3	30	29	80	139
1-4	80	3	80	163
1-5	30	43	46	119
1-6	50	2	10	62
1-7	10	6	10	26
1-8	10	12	48	70
1-9	80	1	10	91
1-10	14	3	69	86
1-11	48	80	80	208
1-12	80	80	46	206

^aMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

^bCLS = combined learning score.

TABLE 13
NONVERBAL LEARNING SCORES
ACHIEVED BY RIGHT BRAIN-DAMAGED SUBJECTS

Subject	METHOD ^a			CLS ^b
	A	C	AC	
2-1	80	25	10	115
2-2	10	11	10	31
2-3	10	80	80	170
2-4	30	2	80	112
2-5	10	63	10	83
2-6	50	2	70	122
2-7	80	80	50	210
2-8	10	11	30	51
2-9	80	1	48	129
2-10	80	3	28	111
2-11	10	35	25	70
2-12	80	80	23	183

^aMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

^bCLS = combined learning score.

TABLE 14
NONVERBAL LEARNING SCORES
ACHIEVED BY NON-BRAIN-DAMAGED SUBJECTS

Subject	METHOD ^a			
	A	C	AC	CLS ^b
3-1	80	3	10	93
3-2	41	50	27	118
3-3	23	5	42	70
3-4	28	19	68	115
3-5	10	80	22	112
3-6	27	1	10	38
3-7	10	48	10	68
3-8	49	64	80	193
3-9	80	22	25	127
3-10	80	1	10	91
3-11	10	5	29	44
3-12	21	17	10	48

^aMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

^bCLS = combined learning score.

TABLE 15
NONVERBAL LEARNING SCORES
COMPARISON OF ALL GROUPS

METHOD ^a		GROUP ^b		
		LBD	RBD	NBD
A	Range	10-80	10-80	10-80
	Median	49.0	20.0	27.5
	Mean	49.3	44.2	38.3
C	Range	1-80	1-80	1-80
	Median	9.0	18.0	18.0
	Mean	28.3	32.8	26.3
AC	Range	10-80	10-80	10-80
	Median	46.0	29.0	23.5
	Mean	41.6	38.7	28.6
CLS	Range	26-208	31-210	38-193
	Median	105.0	113.5	92.0
	Mean	118.9	115.6	93.1

^aMethod: A = antecedent; C = consequent; AC = antecedent plus consequent; CLS = combined learning score.

^bGroup: LBD = left brain-damaged; RBD = right brain-damaged; NBD = non-brain-damaged.

TABLE 16
NONVERBAL LEARNING SCORES BY TASK
COMPARISON OF ALL GROUPS

TASK ^a		GROUP ^b		
		LBD	RBD	NBD
I	Range	6-80	11-80	17-80
	Median	80.0	80.0	59.0
	Mean	60.1	61.6	56.8
II	Range	1-48	1-70	1-49
	Median	10.0	10.0	10.0
	Mean	16.8	18.7	16.2
III	Range	1-80	2-80	1-64
	Median	37.5	29.0	15.5
	Mean	42.3	35.3	20.2
Mean Score All Groups Combined				
I			59.5	
II			17.2	
III			32.6	

^aTask: I = size; II = shading; III = border.

^bGroup: LBD = left brain-damaged; RBD = right brain-damaged;
NBD = non-brain-damaged.

permitted the presentation of all tasks and all methods to each subject, and this order of presentation was consistent among groups. The data shown in Tables 12-15, when arranged by task, were also subjected to a one-way ANOVA and again yielded no statistically significant difference among groups with respect to the categorization rules to be learned. That is, Task I was of comparable difficulty for all groups, and likewise for Task II and Task III.

Language Ability

The experimental and two control groups were compared with respect to language/communicative ability as measured by the PICA. Tables 17, 18, and 19 show subtest mean scores by response modality for LBD, RBD, and NBD groups, respectively. The range and overall mean scores by subject group are shown in Table 20. Data were subjected to a one-way ANOVA which discerned a difference among groups. The Duncan's multiple range procedure was then applied. Statistical analyses yielded significant differences ($p < .05$) as follows. On the PICA Gestural and Verbal subtests, the LBD group performed significantly more poorly than either the RBD or NBD groups. On the PICA Graphic subtests, the LBD and RBD groups performed significantly more poorly than the NBD group. The overall mean scores, derived from all 18 subtests of the PICA, significantly differentiated all three groups. The LBD group performed more poorly than the RBD group, and the RBD group performed more poorly than the NBD group at statistically significant levels.

TABLE 17
 MEAN SCORES BY MODALITY
 ON THE PORCH INDEX OF COMMUNICATIVE ABILITY
 ACHIEVED BY LEFT BRAIN-DAMAGED SUBJECTS

Subject	MODALITY			
	Gestural	Verbal	Graphic	Overall
1-1	12.54	8.53	8.33	10.24
1-2	13.33	9.10	9.07	10.97
1-3	12.05	8.53	7.46	9.74
1-4	13.51	12.15	10.75	12.29
1-5	11.28	2.00	8.33	8.20
1-6	13.31	11.68	10.85	12.13
1-7	13.53	7.43	11.80	11.59
1-8	13.73	12.65	10.87	12.54
1-9	13.89	12.08	12.78	13.12
1-10	12.11	7.43	8.23	9.78
1-11	12.46	11.23	9.33	11.14
1-12	12.86	12.53	9.95	11.82

TABLE 18
 MEAN SCORES BY MODALITY
 ON THE PORCH INDEX OF COMMUNICATIVE ABILITY
 ACHIEVED BY RIGHT BRAIN-DAMAGED SUBJECTS

Subject	MODALITY			
	Gestural	Verbal	Graphic	Overall
2-1	14.39	14.68	8.12	12.36
2-2	13.85	13.70	11.80	13.13
2-3	13.98	14.33	9.63	12.61
2-4	13.94	14.43	11.40	13.20
2-5	14.36	14.30	12.32	13.67
2-6	14.36	13.85	12.45	13.61
2-7	14.23	14.05	11.02	13.12
2-8	14.15	9.60	7.03	10.77
2-9	14.58	14.58	9.62	12.92
2-10	14.26	13.58	7.53	11.87
2-11	12.94	14.45	12.20	13.03
2-12	14.08	13.63	9.28	12.38

TABLE 19
 MEAN SCORES BY MODALITY
 ON THE PORCH INDEX OF COMMUNICATIVE ABILITY
 ACHIEVED BY NON-BRAIN-DAMAGED SUBJECTS

Subject	MODALITY			
	Gestural	Verbal	Graphic	Overall
3-1	13.98	14.85	12.37	13.63
3-2	14.23	14.75	12.35	13.72
3-3	14.51	14.93	14.27	14.52
3-4	14.21	14.08	12.68	13.67
3-5	14.69	14.20	12.00	13.68
3-6	14.00	14.25	13.05	13.74
3-7	14.20	13.93	14.52	14.24
3-8	13.67	14.50	12.25	13.38
3-9	14.18	14.80	13.92	14.23
3-10	13.75	14.40	13.13	13.69
3-11	14.71	14.75	14.10	14.52
3-12	14.44	14.08	11.93	13.52

TABLE 20
COMPARISON OF ALL GROUPS
ON THE PORCH INDEX OF COMMUNICATIVE ABILITY

MODALITY ^a		GROUP ^b		
		LBD	RBD	NBD
GST	Range	11.28-13.89	12.94-14.58	13.67-14.71
	Mean	12.88 *	14.09	14.21
VBL	Range	2.00-12.65	9.60-14.68	13.93-14.93
	Mean	9.61 *	13.77	14.46
GPH	Range	7.46-12.78	7.03-12.45	11.93-14.52
	Mean	9.81	10.20	13.05 *
CA	Range	8.20-13.12	10.77-13.67	13.38-14.52
	Mean	11.13 *	12.73 *	13.88 *

* $p < .05$

^aModality: GST = Gestural; VBL = Verbal; GPH = Graphic; CA = overall.

^bGroup: LBD = left brain-damaged; RBD = right brain-damaged; NBD = non-brain-damaged.

Abstract Visual Reasoning

The experimental and control groups were compared with respect to visual abstract reasoning as measured by the RCPM. Table 21 reports raw scores, range, median and mean scores for all three groups. A one-way ANOVA was applied and no statistically significant differences among groups were found.

Immediate Memory

The data for immediate memory for LBD, RBD, and NBD groups are shown in Tables 22, 23, and 24. Range, median and mean scores are compiled in Table 25 for all three groups. An ANOVA followed by the Duncan's multiple range procedure found LBD subjects to be significantly poorer in immediate memory for digits, using either auditory stimulus - visual response (AV), or visual stimulus - visual response (VV) than both RBD and NBD groups. Immediate memory for geometric forms (GF) using visual stimulus - visual response (VV) was also significantly depressed in the LBD group, but only in contrast to the NBD group. The RBD group was not significantly different from either the LBD or NBD group on visual memory for geometric forms. Thus, the LBD group showed the greatest immediate memory deficit regardless of modality or content, the RBD group ranked second, while the NBD group was superior.

Cognitive Tempo

From subjects' performance on the MTT test, latency of response and accuracy on the first trial for 12 items were recorded. These data are shown in Tables 26, 27, and 28 for the LBD, RBD, and NBD groups, respectively. A summary of latency and accuracy data for

TABLE 21
COMPARISON OF ALL GROUPS
ON RAVEN'S COLOURED PROGRESSIVE MATRICES

Subject	GROUP ^a		
	LBD	RBD	NBD
1	30	25	19
2	21	25	27
3	31	13	20
4	23	27	24
5	12	32	24
6	27	22	25
7	36	11	29
8	14	27	14
9	30	17	24
10	19	20	28
11	22	21	28
12	21	22	27
Range	12-36	11-32	14-29
Median	22.5	22.0	24.5
Mean	23.8	21.8	24.1

^aGroup: LBD = left brain-damaged; RBD = right brain-damaged;
NBD = non-brain-damaged.

TABLE 22
IMMEDIATE MEMORY FOR DIGITS AND FORMS
BY LEFT BRAIN-DAMAGED SUBJECTS

Subject	DIGITS		FORMS
	Auditory- Visual	Visual- Visual	Visual- Visual
1-1	2	2	1
1-2	2	3	2
1-3	2	3	2
1-4	2	2	1
1-5	1	2	2
1-6	3	4	2
1-7	3	5	4
1-8	5	6	3
1-9	5	6	2
1-10	3	4	2
1-11	7	4	2
1-12	4	2	1

TABLE 23
IMMEDIATE MEMORY FOR DIGITS AND FORMS
BY RIGHT BRAIN-DAMAGED SUBJECTS

Subject	DIGITS		FORMS
	Auditory- Visual	Visual- Visual	Visual- Visual
2-1	6	6	3
2-2	6	7	2
2-3	5	4	1
2-4	5	5	5
2-5	7	6	3
2-6	5	6	3
2-7	7	4	1
2-8	5	6	2
2-9	6	3	2
2-10	5	5	3
2-11	6	5	4
2-12	7	5	1

TABLE 24
IMMEDIATE MEMORY FOR DIGITS AND FORMS
BY NON-BRAIN-DAMAGED SUBJECTS

Subject	DIGITS		FORMS
	Auditory- Visual	Visual- Visual	Visual- Visual
3-1	6	5	3
3-2	6	6	2
3-3	6	6	3
3-4	5	7	3
3-5	5	6	3
3-6	5	7	4
3-7	7	7	4
3-8	5	4	2
3-9	5	6	4
3-10	7	7	5
3-11	5	6	2
3-12	7	7	3

TABLE 25
IMMEDIATE MEMORY FOR DIGITS AND FORMS
COMPARISON OF ALL GROUPS

TASK		GROUP		
		LBD	RBD	NBD
DIGITS				
AV ^a	Range	1-7	5-7	5-7
	Median	3.0	6.0	5.5
	Mean	3.25 *	5.75	5.83
VV ^b	Range	2-6	3-7	3-7
	Median	3.5	5.0	6.0
	Mean	3.58 *	5.17	6.17
FORMS				
VV ^b	Range	1-4	1-5	2-5
	Median	2.0	2.5	3.0
	Mean	2.00 *	2.50	3.17 *

* $p < .05$

^aAV = auditory-visual presentation.

^bVV = visual-visual presentation.

TABLE 26
 FIRST TRIAL ACCURACY AND LATENCY
 FOR MATCHING FAMILIAR FIGURES
 BY LEFT BRAIN-DAMAGED SUBJECTS

Subject	ACCURACY (maximum=12)	LATENCY (seconds)	CLASSIFICATION ^a
1-1	10	94.0	R
1-2	11	77.4	R
1-3	7	27.7	I
1-4	7	29.1	N
1-5	3	33.9	N
1-6	9	40.4	R
1-7	12	39.2	R
1-8	8	18.8	N
1-9	9	35.3	R
1-10	4	22.7	I
1-11	7	15.0	I
1-12	5	46.6	N

^aClassification: R = reflective; I = impulsive; N = neither.

TABLE 27
 FIRST TRIAL ACCURACY AND LATENCY
 FOR MATCHING FAMILIAR FIGURES
 BY RIGHT BRAIN-DAMAGED SUBJECTS

Subject	ACCURACY (maximum=12)	LATENCY (seconds)	CLASSIFICATION ^a
2-1	5	26.0	I
2-2	3	26.6	I
2-3	6	48.3	N
2-4	7	17.6	I
2-5	11	31.8	R
2-6	8	33.3	R
2-7	4	16.7	I
2-8	5	28.2	I
2-9	1	20.6	I
2-10	9	48.8	R
2-11	6	19.6	I
2-12	5	24.9	I

^aClassification: R = reflective; I = impulsive; N = neither.

TABLE 28
FIRST TRIAL ACCURACY AND LATENCY
FOR MATCHING FAMILIAR FIGURES
BY NON-BRAIN-DAMAGED SUBJECTS

Subject	ACCURACY (maximum=12)	LATENCY (seconds)	CLASSIFICATION ^a
3-1	6	16.5	I
3-2	6	16.2	I
3-3	9	84.7	R
3-4	7	29.6	N
3-5	9	66.1	R
3-6	6	9.2	I
3-7	10	92.3	R
3-8	2	11.9	I
3-9	9	35.3	R
3-10	3	29.1	N
3-11	9	19.4	N
3-12	7	15.9	I

^aClassification: R = reflective; I = impulsive; N = neither.

all three groups is shown in Table 29. A one-way ANOVA yielded no significant statistical difference among groups for first trial latency or accuracy.

Using the procedure described by Messer (1976), the average latency of response and overall accuracy scores were used to classify subjects as "reflective" (R) or "impulsive" (I), or "neither" (N). Given a two by two matrix, the reflectives and impulsives comprise about 2/3 of most samples, according to Messer (1976). Reflectives are those subjects who are below the median on response time and above the median on accuracy, while impulsives are above the median on response time and below the median on accuracy. This median split procedure was done, using data from all three groups combined. Table 30 shows median values for latency and accuracy as well as the range of scores resulting from the median split. Subjects in the experimental and control groups were then classified as shown in Figure 14, as reflective, impulsive or neither. In the LBD group, 5 subjects were classified as reflective, 3 as impulsive, and 4 as neither. In the RBD group, 3 subjects were reflective; 8, impulsive; and 1, neither. In the NBD group, 4 subjects were reflective; 5, impulsive; and 3, neither. Tables 26, 27, and 28 show the cognitive tempo classifications for each subject.

The total trials necessary to attain a problem solution on the MFF test was computed as a supplementary measure of the ability to match figures. This was computed by allowing retrials up to a maximum of 6 on each test item. Descriptive data for total trials to solution for all groups are shown in Table 31. A one-way ANOVA yielded a statistically significant difference among groups for total-trials

TABLE 29
COMPARISON OF ALL GROUPS
ON ACCURACY AND LATENCY SCORES
FOR MATCHING FAMILIAR FIGURES

		GROUP ^a		
		LBD	RBD	NBD
First Trial Accuracy (maximum = 12)	Range	3-12	1-11	2-10
	Median	7.5	5.5	7.0
	Mean	7.7	5.8	6.9
First Trial Latency (seconds)	Range	15.0-94.0	16.7-48.8	9.2-92.3
	Median	34.6	26.3	24.3
	Mean	40.0	28.5	35.5

^aGroup: LBD = left brain-damaged; RBD - right brain-damaged;
NBD = non-brain-damaged.

TABLE 30
MEDIAN SPLIT DATA
ON WHICH COGNITIVE TEMPO CLASSIFICATIONS ARE BASED

	ACCURACY		LATENCY	
	poor	good	fast	slow
Range	3-7	8-12	9.2-28.2	29.1-94.1
Median		7.5		28.65

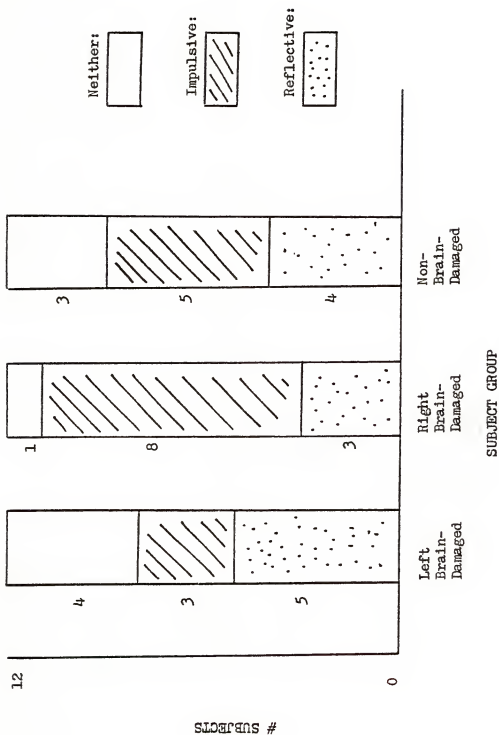


FIGURE 15
COGNITIVE TEMPO CLASSIFICATIONS
BY SUBJECT GROUP

TABLE 31
TOTAL TRIALS TO SOLUTION
FOR MATCHING FAMILIAR FIGURES
COMPARISON OF ALL GROUPS

Subject	GROUP ^a		
	LBD	RBD	NBD
1	14	27	26
2	15	28	27
3	18	32	15
4	17	23	27
5	25	13	15
6	15	17	23
7	12	42	14
8	23	21	30
9	15	40	18
10	28	20	23
11	17	32	15
12	23	26	18
Range	12-28	13-42	14-30
Median	17.0	26.5	18.0
Mean	18.50	26.75 *	20.08

* $p < .05$

^aGroup: LBD = left brain-damaged; RBD = right brain-damaged;
NBD = non-brain-damaged.

accuracy. The Duncan's multiple range procedure was then applied to these data, and the RBD group was found to require a significantly greater number of trials ($p < .05$) to achieve an accurate matching response. This finding implies poorer accuracy overall by the RBD group relative to the other groups. The LBD and NBD groups showed no statistically significant difference on total trials to solution.

Interaction of Variables

Method by Group

In order to determine if any one of the three teaching methods affected learning in any particular subject group, an ANOVA was used to test method by group interaction. As shown in Table 32, no interaction existed, indicating that all methods effected similar learning rates in all three groups of subjects.

Method by Task

The possibility that teaching method might vary in its effectiveness depending on the nonverbal rule to be learned was assessed. With data from all groups combined, a one-way ANOVA was used to compare the learning scores obtained from each method (e.g., Task II, Method A versus C versus AC). The ANOVA was significant so Duncan's multiple range procedure was used to compare the three means (see Table 33). This test showed Method C produced significantly lower (better) scores than either Method A or AC for Task II. No other task by method interactions were statistically significant when data for all groups were combined.

TABLE 32
METHOD AND GROUP INTERACTIONS
AFFECTING NONVERBAL LEARNING

SOURCE	d.f.	S.S.	M.S.	
Method	2	3948.574	1974.287	NS
Group	2	1579.630	789.815	NS
Subject (Group)	33	29788.917	902.694	NS
Method x Group	4	498.093	124.523	NS
Error	66	58478.667	886.040	
Total	107	94293.881		

TABLE 33
METHOD AND TASK INTERACTIONS
AFFECTING NONVERBAL LEARNING
FOR ALL GROUPS COMBINED

TASK ^a	METHOD ^b	N	MEAN	S.D.	
I	A	12	65.08	23.92	NS
	C	12	53.17	28.84	NS
	AC	12	60.17	23.39	NS
II	A	12	20.83	15.15	NS
	C	12	7.00	9.18	*
	AC	12	23.50	20.85	NS
III	A	12	45.83	31.48	NS
	C	12	27.17	30.79	NS
	AC	12	24.83	19.17	NS

* $p < .05$

^a Task: I = size; II = shading; III = border.

^b Method: A = antecedent; C = consequent; AC = antecedent-plus consequent.

Method by Cognitive Tempo

From the total sample of subjects ($N = 36$), 12 were classified as reflective and 16 were classified as impulsive. In order to determine the possible interaction between teaching method and reflectivity-impulsivity, a two-way ANOVA for each cognitive style class was run to compare the 3 teaching methods. As shown in Table 34, neither of the tests was significant, implying no difference between the 3 teaching methods for either cognitive tempo classification. Despite a lack of significance in the statistical analysis, it was of interest to note the performance trends as shown in Figure 16. The reflective group showed a decrease in score (i.e., improved) from Method A to C to AC. The impulsive group was comparable to the reflective group under Methods A and C, but showed an increase in score (i.e., performed more poorly) from Method C to AC.

As shown in Figure 15, the reflective-impulsive classification was applied to each subject group separately. This within-group comparison of cognitive tempo permitted an analysis of the interaction between teaching method and cognitive tempo for each subject group. The analysis performed was a two-way ANOVA in each of the 6 group combinations formed. The 2 factors in each analysis were teaching method and subject group. Descriptive statistics are presented in Table 35. The ANOVA for LBD aphasic reflective subjects was significant ($p < .02$) and for LBD aphasic impulsive subjects, almost significant ($p < .07$). Duncan's multiple range test was then applied to LBD reflective scores. Teaching Method A produced significantly higher scores (reflecting poorer performance) than either Method C or Method AC.

TABLE 34
 METHOD AND COGNITIVE TEMPO INTERACTIONS
 AFFECTING NONVERBAL LEARNING
 FOR ALL GROUPS COMBINED

COGNITIVE TEMPO	METHOD ^a	N	MEAN	S.D.	
Reflective	A	12	46.92	32.35	NS
	C	12	26.08	32.30	NS
	AC	12	21.08	18.73	NS
Impulsive	A	16	43.13	28.40	NS
	C	16	30.75	30.46	NS
	AC	16	40.13	29.08	NS

^aMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

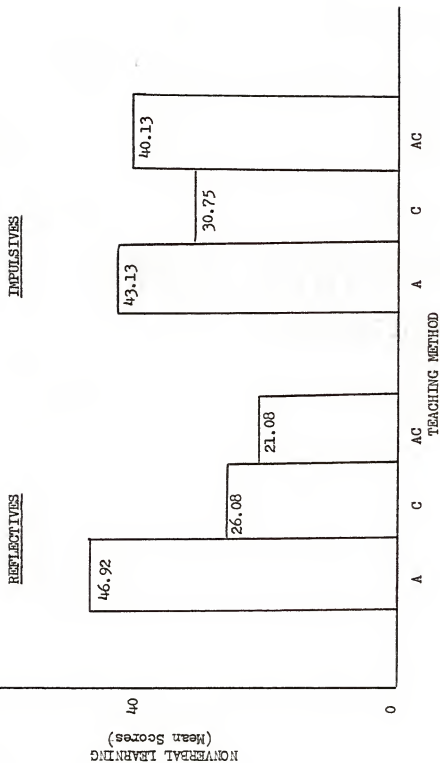


FIGURE 16
EFFICACY OF METHODS RELATIVE TO COGNITIVE TEMPO (ALL GROUPS)

TABLE 35
METHOD AND COGNITIVE TEMPO INTERACTIONS
AFFECTING NONVERBAL LEARNING
FOR EACH SUBJECT GROUP

COGNITIVE TEMPO	GROUP ^a	METHOD ^b	N	MEAN	S.D.	
Reflective	LBD	A	5	60.0	30.82	*
		C	5	3.2	2.59	NS
		AC	5	24.0	31.30	NS
	RBD	A	3	46.7	35.12	NS
		C	3	22.7	34.93	NS
		AC	3	36.0	30.79	NS
	NBD	A	4	30.8	33.40	NS
		C	4	38.8	32.69	NS
		AC	4	24.8	13.20	NS

TABLE 35 - CONTINUED

COGNITIVE TEMPO	GROUP ^a	METHOD ^b	N	MEAN	S. D.
Impulsive	LBD	A	3	30.7	17.01
		C	3	37.3	39.17
		AC	3	76.3	6.35
	RBD	A	8	47.5	35.36
		C	8	30.6	32.50
		AC	8	34.5	23.71
	NBD	A	5	43.6	23.17
		C	5	27.0	28.50
		AC	5	27.4	30.31

* $p < .05$ ^aGroup: LBD = left brain-damaged; RBD = right brain-damaged; NBD = non-brain-damaged.^bMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

The small sample sizes may have precluded the finding of statistically significant differences among the other comparisons. Presentation of data in Figures 17, 18 and 19 is enlightening with respect to the trends which obtain between reflectives and impulsives in the LBD, RBD, and NBD groups, respectively. As the statistical analysis suggested, the sharpest differences among teaching methods occurred for those individuals in the LBD group classified as either reflective or impulsive (8 of the 12 subjects), as shown in Figure 17. In the reflective subgroup, Method A was significantly poorer than either Methods C or AC. In the impulsive subgroup, Method AC was poorer than either Methods A or C, and this difference nearly reached statistical significance. The contrast between reflectives and impulsives was striking. Performance with respect to teaching method, in order from best to worst was, for the reflectives: C then AC then A; for the impulsives: A then C then AC.

As shown in Figure 18, teaching methods did not have as great a differential effect on learning for those individuals classified as reflective or impulsive in the RBD group (11 of the 12 subjects). No statistically significant differences among teaching methods occurred for either RBD reflectives or RBD impulsives. Performance with respect to teaching methods in order from best to worst was the same for reflectives and impulsives: C then AC then A.

As shown in Figure 19, teaching methods showed little differential effect on learning for those individuals in the NBD group classified as reflective or impulsive (9 of the 12 subjects). Performance with respect to teaching method in order from best to worst was, for the reflectives: AC then A then C; for the impulsives: C then AC then A.

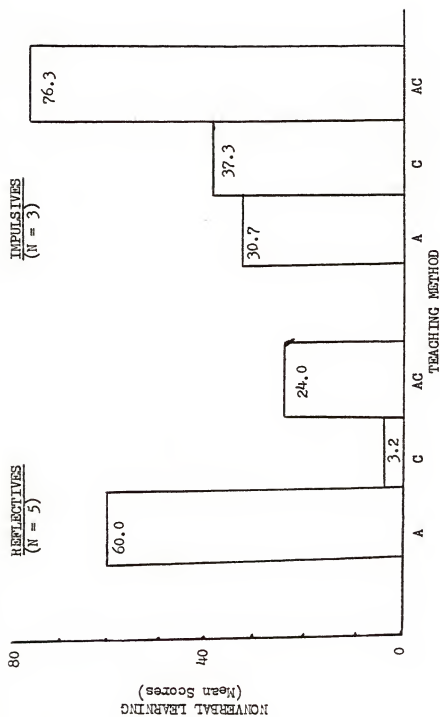


FIGURE 17
EFFICACY OF METHODS RELATIVE TO COGNITIVE TEMPO
(LEFT BRAIN-DAMAGED SUBJECTS)

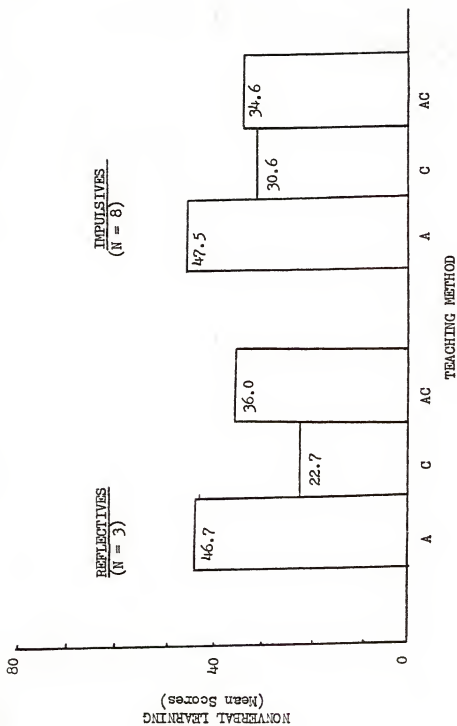


FIGURE 18
EFFICACY OF METHODS RELATIVE TO COGNITIVE TEMPO
(RIGHT BRAIN-DAMAGED SUBJECTS)

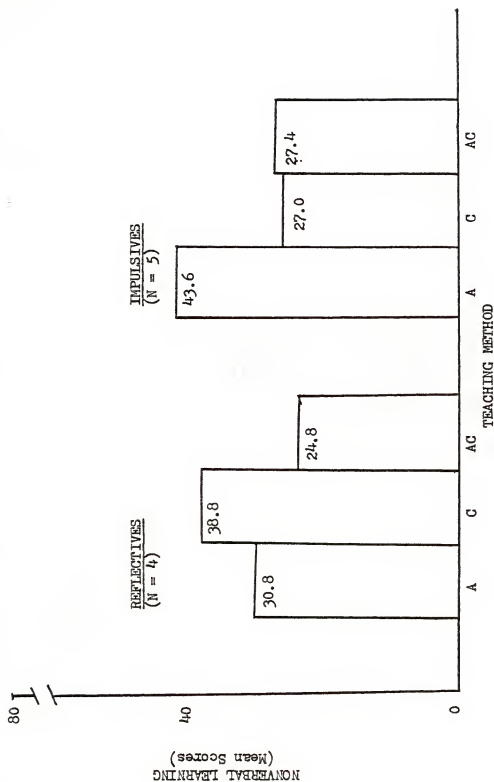


FIGURE 19
EFFICACY OF METHODS RELATIVE TO COGNITIVE TEMPO
(NON-BRAIN-DAMAGED SUBJECTS)

Correlation Analyses

Nonverbal Learning and Language Ability

For each subject group, the relationship of learning rate to language ability was analyzed using Pearson's correlation coefficient. PICA Gestural (GST), Verbal (VBL) and Graphic (GPH) and Overall (QA) mean scores were correlated with the rate of learning scores for teaching methods A, C and AC, as well as the combined learning score (CLS). The correlation coefficients are shown in Table 36 for LBD, RBD and NBD groups. With one exception, these results indicated no significant correlation between nonverbal rule learning and language/communicative ability as measured by the PICA.

Nonverbal Learning and Visual Abstract Reasoning

For each subject group, the relationship of nonverbal learning to visual abstract reasoning as measured by the RCPM was analyzed using Pearson's correlation coefficient. The RCPM raw score was correlated with learning scores obtained from methods A, C and AC, and the CLS. The correlation coefficients are shown in Table 37. There were no statistically significant correlations in the LBD group. In the RBD group, the RCPM correlated highly with the CLS ($p < .02$). In the NBD group, the RCPM correlated with Method AC ($p < .03$) and CLS ($p < .03$). All the significant correlations were negative, implying that as one score increased the other decreased. Because a high score on the nonverbal learning tasks reflected poor performance, these significant correlations mean that better nonverbal learning was associated with better performance on the RCPM.

TABLE 36
 PEARSON'S CORRELATION COEFFICIENTS
 BETWEEN LEARNING RATE AND LANGUAGE PERFORMANCE

GROUP ^a	METHOD ^b	LANGUAGE MODALITY ^c			
		GST	VBL	GPH	QA
LBD	A	.26	.40	.13	.31
	C	-.42	.03	-.26	-.19
	AC	-.31	-.01	-.52	-.28
	CLS	-.25	.22	-.34	-.09
RBD	A	.53	.27	-.37	-.07
	C	-.10	.18	.11	.13
	AC	.07	.14	.17	.20
	CLS	.30	.36	-.08	.14
NBD	A	-.70 *	.46	-.13	-.27
	C	.09	-.29	-.34	-.30
	AC	-.16	.09	-.12	-.14
	CLS	-.46	.16	-.36	-.43

* $p < .05$

^aGroup: LBD = left brain-damaged; RBD = right brain-damaged; NBD = non-brain-damaged.

^bMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

^cLanguage Modality: GST = gestural; VBL = verbal; GPH = graphic; QA = overall, as measured by the Porch Index of Communicative Ability.

TABLE 37
 PEARSON'S CORRELATION COEFFICIENTS
 BETWEEN LEARNING RATE AND VISUAL ABSTRACT REASONING

METHOD ^a	VISUAL ABSTRACT REASONING ^b BY SUBJECT GROUP ^c		
	LBD	RBD	NBD
A	.15	-.39	-.29
C	-.31	-.35	-.18
AC	-.44	-.46	-.62 *
CLS	-.32	-.70 *	-.63 *

* $p < .05$

^aMethod: A = antecedent; C = consequent; AC = antecedent plus consequent.

^bVisual Abstract Reasoning: as measured by Raven's Coloured Progressive Matrices.

^cSubject Group: LBD = left brain-damaged; RBD = right brain-damaged; NBD = non-brain-damaged.

TABLE 38
PEARSON'S CORRELATION COEFFICIENTS
BETWEEN LEARNING RATE AND IMMEDIATE MEMORY

GROUP ^a	METHOD ^b	IMMEDIATE MEMORY		
		DIGITS AV ^c	DIGITS VV ^d	FORMS VV ^d
LBD	A	.05	-.43	-.75 **
	C	.42	-.30	-.21
	AC	-.01	-.32	-.24
	CLS	.19	-.54	-.62 *
RBD	A	.25	-.41	-.23
	C	.62 *	-.25	-.58 *
	AC	-.53	-.50	.06
	CLS	.29	-.67 *	-.48
NBD	A	.08	-.31	.35
	C	-.18	-.35	-.35
	AC	-.52	-.49	-.53
	CLS	-.34	-.67 *	-.28

* $p < .05$

** $p < .01$

^aGroup: LBD = left brain-damaged; RBD = right brain-damaged;
NBD = non-brain-damaged.

^bMethod: A = antecedent; C = consequent; AC = antecedent plus
consequent.

^cAV = auditory-visual presentation.

^dVV = visual-visual presentation

Nonverbal Learning and Immediate Memory

For each subject group, the relationship of learning rate to immediate memory was analyzed using Pearson's correlation coefficient. Immediate memory for digits (AV), digits (VV) and geometric forms (VV) were correlated with Methods A, C, AC and CLS for each group separately. Significant correlations were as follows. In the LBD group, immediate memory for forms (VV) was negatively correlated with Method A and CLS. In the RBD group, immediate memory for digits (AV) was positively correlated with Method C. In the RBD group, negative correlations occurred between immediate memory for digits (VV) and CLS, as well as for geometric forms (VV) and Method C. In the NBD group, immediate memory for digits (VV) was negatively correlated with CLS. The correlation coefficients are shown in Table 38.

Summary of Results

Group comparisons, analyses of interactions among variables, and correlation analyses are summarized below.

1. LBD, RBD and NBD subject groups did not differ significantly in their nonverbal rule learning ability for 3 experimental tasks requiring a 2-category sorting response, and for the combined learning score.

2. LBD, RBD and NBD subject groups did not differ in the ability to learn nonverbal categorization rules under 3 specified teaching methods: Method A (antecedent model), Method C (consequent corrective feedback), or Method AC (antecedent model plus consequent corrective feedback).

3. LBD, RBD and NBD subject groups were significantly different in overall language/communicative ability in the expected direction (aphasics performed least well and NBD subjects performed the best).

4. Nonverbal learning was not significantly related to language ability in any subject group.

5. LBD, RBD and NBD subject groups were not significantly different in visual abstract reasoning ability as measured by the RCPM.

6. Nonverbal learning was not significantly related to visual abstract reasoning in the LBD aphasic group. In contrast, statistically significant positive relationships between nonverbal learning and visual abstract reasoning occurred in the NBD and RBD groups, but these were not observed across all teaching methods. The relationship between nonverbal learning and visual abstract reasoning appeared to be strongest for the RBD group.

7. The LBD aphasic subject group presented significantly poorer immediate memory for digits presented either auditorily or visually, in contrast to RBD and NBD subject groups. RBD and NBD groups were not significantly different from each other on these tasks.

8. The LBD aphasic group exhibited significantly poorer immediate memory for visually presented geometric forms in contrast to the NBD subject group. The RBD subject group performed at an intermediate level and did not differ significantly from either the LBD or NBD subject groups.

9. Nonverbal learning was significantly correlated with immediate memory for digits and geometric forms but these relationships were

inconsistent among methods and groups, suggesting that nonverbal learning was not strongly influenced by immediate recall of digits and/or forms in any group of subjects.

10. The cognitive tempo composition of subject groups, as measured by the MTT test, was identified as follows. In the LBD aphasic group, 5 subjects were reflective; 4, impulsive; and 3, neither. In the RBD group, 3 subjects were reflective; 8, impulsive; and 1, neither. In the NBD group, 4 subjects were reflective; 5, impulsive; and 3, neither.

11. Reflective subjects in the LBD, RBD and NBD groups combined ($N = 12$) in comparison to impulsive subjects from all groups combined ($N = 16$) were not significantly different in terms of nonverbal learning performance for any of the 3 experimental teaching methods.

12. An analysis of the interaction between teaching method and cognitive style for LBD, RBD and NBD groups separately, yielded a significantly different effect of teaching methods in the aphasic reflective subgroup only: Method C (corrective feedback) and Method AC (model and corrective feedback) were significantly more effective than Method A (model alone).

CHAPTER 4 DISCUSSION AND IMPLICATIONS

Discussion

The variables that affect learning ability and learning potential in the adult aphasic individual have not been fully defined. The ability to perform conceptual tasks or acquire novel material appears to be limited by brain damage, but the impact of aphasia on such performance is unclear. To assert that a learning deficit exists is not sufficient. According to Winitz (1976), the clinician must explore both learner variables and task variables and assess the compatibility of these two domains. Then he must relate this information to the specific linguistic deficiencies of the individual. This complex analysis will, it is hoped, allow the clinician to help the individual with aphasia overcome behavioral/linguistic deficits and optimize recovery. The purpose of this study was to determine the efficacy of 3 teaching methods for aphasic individuals on a nonverbal categorization (rule) task relative to their cognitive tempo attributes. Cognitive tempo, defined by both temporal and perceptual aspects of responding to a visual matching problem, had not been previously investigated in aphasia. A comparison of left brain-damaged aphasic individuals with right brain-damaged and non-brain-damaged individuals was made with respect to learning, language, abstract visual reasoning, immediate memory and cognitive tempo in order to interpret the primary findings of this study.

Nonverbal Learning

Teaching method

The ability to learn nonverbal (visual) categorization tasks using 3 teaching methods defined in terms of antecedent and consequent events was evaluated. The experimental subjects, LBD aphasics, did not differ from RBD and NBD control subjects in the ability to learn nonverbal rules using 3 teaching methods: Method A (antecedent model alone), Method C (consequent corrective feedback), and AC (antecedent-plus-consequent feedback). These findings may imply that the propensity to learn within specified behavioral settings is not affected by central neurologic pathology and/or aphasia. Comparable performance of brain-damaged and non-brain-damaged subjects in this study suggested that sensitivity to teaching method differences is not affected by cerebral insult. On the other hand, it should be recognized that the A, C and AC methods chosen for study were highly select manipulations and can not be considered to be an exhaustive exploration of the constructs of "antecedent" versus "consequent" events. The procedures of "modelling," giving "corrective feedback" and a combination of these can be enhanced or further limited in potency in a variety of ways, e.g., by manipulating modality, intensity, frequency, etc. Future research could explore these variables.

Difficulty of learning tasks

The nonverbal tasks developed for this study involved the learning of categorization responses on the basis of three rules: size, shading, and border. On each task, the rule governing classification was systematically combined with irrelevant stimuli. All 3

tasks were presented to each subject. The experimental tasks were conceived to be similar but more difficult than the Wisconsin Card-Sorting Task (refer to Appendix D) and the variants of the WCST that have been used experimentally by others. Messerli and Tissot (Lebrun and Hoops, 1974) have suggested that the single-feature categorization task is simpler than a task requiring the isolation of one feature when several are presented simultaneously. Verbal mediation is presumed to occur as tasks increase in difficulty and may affect performance in at least 3 ways, according to Voinescu:

It may mean that the task is novel and complex and that in order to perform it, the patient must be able to understand the instructions properly and completely.

It may also mean that the subject has to verbalize what he is doing because he needs his own verbal feedback to proceed with the performance.

It may finally indicate that verbalization regulates the subject's behavior, enabling self-checking and self-correction to take place. (Lebrun and Hoops, 1974, p. 72)

Unfortunately, verbal mediation effects must be inferred from performance. The assumption in most research addressing this issue has been that if verbal mediation is operative in a task, the aphasia group will be most susceptible to performance decrements. Conversely, when aphasics show performance deficits on ostensibly nonverbal tasks, ineffective verbal mediation is assumed to be the cause. This tautology can be resolved only if the performance deficits of the aphasic group are shown to be directly related to a comprehensive objective measurement of language abilities. In the present study, LED, RBD and NBD subjects differed significantly in overall language abilities as measured by the PICA, but did not differ significantly

in their ability to acquire the experimental nonverbal categorization tasks. These findings disputed the view that aphasics are deficient in the ability to process nonverbal stimuli, thereby precluding support for a verbal mediation hypothesis.

The finding of similar nonverbal learning among groups concurred with the conclusions of Meyers (1948), Bauer and Becka (1954), Zangwill (1964) and Wertz (1967), but failed to support those studies which found left hemisphere-damaged individuals (aphasics and non-aphasics) to be depressed on nonverbal categorization tasks (McFie and Piercy, 1952; McFie and Zangwill, 1960; Poppen et al., 1965; Drewe, 1974; Ettlinger et al., 1975). The finding that the aphasic group in this study did not perform more poorly than the normal group differed from the conclusions of Tikofsky and Reynolds (1962, 1963), DeRenzi et al. (1966), Archibald et al. (1967), and Carson et al. (1968).

The difference in findings of past research and the present study might have been due to differences in task difficulty. Despite the fact that the experimental stimulus set in the present study simultaneously represented 3 dichotomous rules, only a 2-category sorting response was required at any one time. The experimental tasks differed from tasks such as the WCST where 4 stimulus cards are presented simultaneously. However, the range of scores for each group in the present study indicated that the experimental learning tasks were not easy for all subjects. In the LBD group, 11 subjects failed to acquire at least one of the tasks; in the RBD group, 10 subjects; in the NBD group, 5 subjects.

Perceptual salience

The generalizability of teaching method effects across tasks was assessed by statistically analyzing task by method interactions. It was found that Method C produced significantly better scores than either Method A or AC for Task II (shading rule) with data for all groups combined. This finding could be interpreted to mean that teaching method may be differentially effective for select stimulus attributes. While statistical analysis showed no difference among groups for Tasks I, II or III, the tasks per se were clearly of unequal difficulty. The following order of difficulty was observed for all subject groups (from easiest to most difficult): Task II (shading), Task III (border), Task I (size). Thus, the perceptual salience of the shading, border and size cues was apparently different for these experimental materials.

Scoring

It should be noted that teaching methods A and AC differed from method C in one important respect, with consequences for scoring. By definition, A and AC included a sequence of 10 models by the examiner before the subject was allowed to respond. Learning that may have occurred during this model/observation period could not be assessed or confirmed for at least 10 additional consecutive trials by the subject. Thus, the minimum possible score for Methods A or AC was 10, while the minimum score for Method C was 1 (the first response in Method C was assumed to be correct only by chance). Methodologies that involve alternate clinician-patient interaction therefore would appear to be less efficient if one wished to,

1. maximize active responding by the patient per unit time, or
2. to

continuously evaluate learning. Thus, by design, Method C may have resulted in faster learning (fewer trials) because it allowed continuous observation and recording of subject responses.

Language Ability

The PICA was found to be sensitive to aphasic language deficit as measured by the mean scores derived from Gestural and Verbal subtests, on which the LBD aphasics performed significantly poorer than either the RBD or NBD subjects. The RBD subjects were not significantly different from the LBD subjects on Graphic subtests. Subtests on the PICA particularly sensitive to visual-spatial abilities are tests of copying, both words and geometric forms. Significantly depressed performance by RBD subjects on these writing tasks, in contrast to both LBD and NBD performance was felt to be primarily responsible for reduced Graphic modality mean scores in this group. Depressed graphic performance by the LBD aphasic group was attributed primarily to spelling and word retrieval errors. Overall mean scores on the PICA significantly differentiated the 3 subject groups. Thus, the neurophysiologic deficits which distinguished the 3 groups selected for experimental purposes were reflected in the expected direction on a behavioral/linguistic measure.

Some of the abilities assessed by the PICA that might have reflected in learning task performance include auditory comprehension (understanding of task instructions), visual-spatial analysis (of task materials) and verbal expression (for verbal mediation of task solutions). The lack of significant correlation between PICA and learning scores suggested that requirements of the experimental

nonverbal learning tasks on these dimensions did not exceed the perceptual and/or linguistic capabilities for any group of subjects.

Visual Abstract Reasoning

The experimental and control groups did not significantly differ in the ability to perform on the RCPM, a visual abstract reasoning measure. Thus, neither brain damage per se nor brain damage with aphasia appeared to cause a decrement in nonverbal reasoning relative to normal performance. This finding concurred with reports that performance on the RCPM does not correlate significantly with side of lesion or aphasia (DeRenzi and Faglioni, 1965; Wertz, 1967), but did not support conclusions of Weisenberg and McBride (1935), Archibald et al. (1967), or Gulton (1969) that language and nonlanguage abilities are systematically related in the aphasic population.

Unlike language scores, the RCPM scores significantly correlated with performance on the nonverbal rule learning tasks presented experimentally. This significant negative correlation occurred in the RBD and the NBD groups. Because a high score on the learning tasks reflected poor performance, these results are interpreted to mean that as performance on the RCPM improved, nonverbal learning also improved. Why this relationship did not also occur for the LBD aphasic subjects is not clear. Though presumably many of the same perceptual/analytic and/or verbal mediation skills that an individual might bring to these two tasks (nonverbal learning and RCPM) are similar, a failure to find a strong relationship for all subject groups implied that these skills are applicable but not essential to such tasks.

Immediate Memory

LBD subjects were significantly impaired on immediate memory tasks involving digits relative to RBD and NBD subjects, and significantly impaired for immediate memory of geometric forms relative to NBD subjects. The finding of depressed performance by aphasics on all tasks was consistent with the findings of Kim (1976), but did not support her finding that RBD individuals were significantly impaired on verbal (digit) and visual-spatial (geometric form) span relative to normals. The data also compared favorably with the findings of DeRenzi and Nichelli (1975) who reported that verbal span in LBD aphasic patients was shorter in comparison to other groups, while RBD patients did not differ from NBD controls. While LBD and RBD subjects performed more poorly than NBD subjects on visual memory for geometric forms in the present study, only LBD subjects were significantly poorer than normal subjects.

Brewer (1969) suggested that depressed memory in aphasic individuals for visually presented stimuli may be related to their ineffective attempts to verbally encode such stimuli. The fact that LBD aphasics in this study were significantly poorer on the visual immediate memory tasks lent support to this hypothesis. However, the memory deficit, whatever the cause, did not appear to carry over to the more difficult learning tasks presented experimentally. Several statistically significant correlations occurred between learning and immediate memory performance. However, the relationship of immediate memory deficits to nonverbal learning, particularly in the LBD aphasic group, where one would anticipate a relationship, was not consistent. The interpretation that a verbal mediation

deficit underlies both visual memory and nonverbal learning abilities was not strongly supported by these data.

Cognitive Tempo

Classification by subject group

When presented with a problem-solving task where several possible solutions are available, an individual's cognitive tempo disposition may affect his learning in predictable ways. Theoretically, the reflective individual considers the alternative response solutions before responding, which results in slow and accurate performance. In contrast, the impulsive individual responds fast and tends to make more errors. When cognitive tempo classifications were made within each subject group, a larger proportion of the RBD group were classified as impulsive (8 of the 12 subjects) in contrast to the LBD group (3 subjects) and the NBD group (5 subjects). Only 3 RBD subjects were classified as reflective, in contrast to 5 individuals in the LBD group and 4 in the NBD group. For the subjects in this study, the LBD aphasic group appeared to be more like the NBD group in cognitive tempo composition than the RBD group. In the literature, LBD individuals have been described as "slow and cautious" and RBD individuals as "impulsive and too fast" (Fowler and Fordyce, 1974, p. 12), but these behavioral dimensions have not been objectively assessed in the neurologically involved adult population. The findings in this study of cognitive tempo differences among groups supported previous observations. Further testing using the MFT test is necessary to confirm the validity of these findings.

The role of modelling

When data from all groups were combined, and the reflectivity-impulsivity dimensions were considered for each group separately, several trends involving the interaction of cognitive style and teaching method were observed. First, reflective subjects -- for all groups combined and for both pathologic groups -- were similar in that they performed least well under Method A. In Method A, the subject's observation of a model alternated with 10 consecutive responses. Feedback as to attainment of a correct categorization response was given at the point where modelling trials switched to response trials. Feedback was never item specific. Method A, in contrast to Methods C and AC was presumed to require observational learning and demand longer retention of solutions tried and discarded. Method A offered the least amount of information in terms of corrective feedback and on the least frequent schedule than either of the other two methods. The interaction between cognitive tempo and teaching method was not statistically significant in all groups. Rather, the reflective subjects within the aphasic group were significantly more susceptible to failure using Method A than their reflective counterparts in the RBD or NBD groups.

The role of feedback

The finding of significantly poorer learning performance in the aphasic reflective subgroup using Method A than by Methods C or AC suggested that corrective feedback was far more effective either alone (Method C) or in combination with a model (Method AC) than an isolated model with intermittent and nonspecific feedback (Method A). One study that is of particular relevance to interpreting

the differences observed in this study are reported by Nuessle (1972). He found reflective subjects were more proficient on a concept identification task than impulsives. Subjects were presented with stimuli which varied along four dimensions (e.g., size and position) with two levels of each (e.g., large versus small; left versus right). The subjects used a trial and error strategy to determine the position of concept dimensions and then were given corrective feedback. Reflective children reportedly made better use of feedback information to solve these tasks than impulsive children. Two findings in the present study were consistent with Nuessle's findings: LBD reflectives performed significantly better using the feedback method than the modelling method; and, though the differences were not statistically significant, LBD reflectives were superior to RBD reflectives using the feedback method.

Within the aphasic group, the contrast between reflective and impulsive subgroups was notable. As stated above, aphasic reflectives found Method A to be least effective. The aphasic impulsive subgroup, however, found Method AC to be the least effective teaching method. Method AC offered 10 consecutive models and then incorporated corrective feedback into the 10 consecutive response trials. In contrast to Methods A or C, which were about equally effective, the variety or redundancy implicit in the AC approach was not facilitative for aphasic impulsive individuals.

The same pattern of differential effects of teaching method for reflectives and impulsives was not observed in the RED and NBD groups as in the LBD aphasic group. The RED and NBD subjects classified either as reflective or impulsive appeared to find all teaching methods to be about equally facilitative.

Central versus incidental learning

Katz (1958) studied the difference in learning by aphasic adults following goal-directed versus incidental instructions. On a picture-recall task, goal-directed instruction was a specific explanation of the task, while incidental instructions were vague and irrelevant. While nonaphasics were superior after goal-directed instruction, aphasics performed poorly under both conditions. Katz suggested that failure to profit from the goal-directed set might have been due to the ". . . inability to retain or maintain the set induced by the goal-directed instructions with sufficient consistency to perform more adequately" (1958, p. 145). Further, irrelevant or incidental cues may have proved distracting, which the aphasic could not overcome due to ". . . deficiencies in the use of implicit verbalizations or cue-producing responses" (1958, p. 145).

Weiner and Berzonsky (1975) attempted to explain incidental or central learning as a function of cognitive tempo. They found that central learning was significantly greater for reflective children than impulsive children. The implication was that the reflectives could ignore irrelevant (incidental) stimuli better than impulsives. It is reasonable to assume that the teaching methods described in this study may have enhanced or minimized the tendency of aphasics to be distracted by incidental cues, and that this tendency bore some relationship to cognitive tempo. For example, the variety of cues in Method AC apparently proved distracting to aphasic impulsives, thereby presumably prohibiting central (rule) learning. Conversely, the absence of continuous feedback in Method A apparently provided too little information

about the central concept to be learned, thereby failing to inhibit the interference of incidental (irrelevant) cues for the aphasic reflective subjects. The relationship between cognitive tempo, teaching method and central versus incidental learning in aphasic adults appears to be a fruitful area for further research.

Temporal factors

Reflectives are, by definition, slower in their responses than impulsives. Research has shown that during this latency period, reflective individuals actively scan the visual material. On the MFF reflectives typically examine more variants and make more eye fixations per stimulus than impulsive individuals (Messer, 1976). Drake (1970) reported that adult reflectives, unlike adult impulsives, scan all the response alternatives before choosing one. During the experimental conditions in which the examiner modelled (Method A and Method AC) the time to view a stimulus was about 5 seconds: the examiner held the teaching stimulus card at midline for approximately 2 seconds and then sorted by moving the card above the category of choice and held it there for visual comparison for about 3 seconds. During Method C, in contrast, the response card was held in the neutral midline position until the subject initiated a pointing (sorting) response. Latency of stimulus exposure varied depending on the individual subject. Conceivably the temporal aspects of the teaching methodologies employed could have affected performance of the subjects -- adversely or positively -- depending on their cognitive tempo disposition.

Spectator and participant roles

In addition to temporal factors, the active (participant) versus

passive (spectator) disposition of subjects may have influenced nonverbal rule learning. In the methods involving modelling (Methods A and AC) the learner observed relatively passively during half of the trials. In Method C, the learner responded continuously. Goodenough (1976), in a review of individual differences pertaining to field dependence, stated that field independent learners (cf. reflectives) tended to adopt an active participant role in the learning process while field dependent (cf. impulsives) learners opted for the passive spectator role. A participant versus spectator predisposition may have had some bearing on the differential effect of teaching methods for the adult aphasics tested. In this study, the participant role presumably necessary to learning in Method C clearly was facilitative to reflective aphasic subjects, a finding which was consistent with Goodenough's conclusion.

Problem-solving strategies

Individual differences in the strategies used to analyze concept attributes may have interacted with teaching methodology in the present study. McKinney observed four strategies used by children on a visual concept problem-solving task:

A focusing strategy was defined as testing one stimulus attribute on each informative trial.

A scanning strategy was defined as testing one stimulus at a time in an orderly fashion . . .

A random strategy was scored when the subject tested specific stimuli without following a discernible pattern.

A mixed strategy was defined as any combination of the three basic approaches. (1973, p. 145)

McKinney found reflective subjects used the more efficient focusing strategy significantly more often than impulsives. He stated:

The data support the conclusion that reflective children attempt to consider several alternative hypotheses and use a strategy that tests the relevance of conceptual categories rather than specific instances. Impulsive children were less likely to form abstract hypotheses and more often used information in a random trial-and-error fashion. (1973, p. 145)

The scoring of experimental tasks in this study was not designed to evaluate types of strategies employed during rule learning. However, identifying such problem-solving strategies relative to cognitive style and teaching method in individual aphasics could potentially affect treatment outcomes, and is another area warranting further investigation.

Rule learning

Individuals who appear to acquire classification responses through rule or hypothesis-testing have been described by Muma (1977) as "rule-learners." He noted that so-called rule-learners will respond within very few trials of affirmative feedback, by either accepting the hypothesis or pursuing a different hypothesis. Using a criterion of 8 consecutive correct responses in a corrective feedback paradigm, Muma found that rule-learners acquire concepts within 12-15 trials. Non-rule-learners, who approach a classification task in a less systematic fashion, require from 30-50 trials, and sometimes many more, in order to achieve criterion.

Nebelkopf and Dreyer (1973) have observed two distinct types of concept learning. Continuous or incremental learning in field-dependent learners contrast with discontinuous or mediational

learning in the field-independent learners. The discontinuous learning approach was defined as follows:

Response to the correct exemplar is gradually built up by adding small increments of habit strength to the positive stimulus and of inhibition to the negative stimulus. The learning curve would thus be characterized by a continuous and positive progression to criterion performance. (1973, p. 655)

Discontinuous or mediational learning is associated with the hypothesis testing strategy of field-independent learners:

The success of \underline{S} on any given trial is dependent upon the correctness of the mediator selected. Hence, until the correct mediator is selected, the learning curve would be represented by a random response sequence, with a sudden discontinuous jump to criterion performance. (1973, p. 655)

Muma's distinction of rule- versus non-rule-learners has a close parallel to discontinuity versus continuity learning described by Nebelkopf and Dreyer. An important exception is that Nebelkopf and Dreyer failed to find a difference in the number of trials to reach criterion performance between the 2 types of learners. It appears tenable that at least 3 types of rule acquisition patterns can occur: spontaneous rule learning, discontinuous hypothesis-testing, and continuous incremental learning. These considerations may help explain the wide range of performance trials among subjects in the present study.

Divergent-convergent behavior

Chapey, Rigrodsky and Morrison (1976) stressed the importance of differentiating divergent and convergent behavior (Guilford, 1967) in aphasia. These concepts were defined as follows:

Divergent behavior involves the generation of logical alternatives from given information; emphasis is upon variety, quantity and relevance of output from the same source. This behavior is concerned with the generation of logical possibilities with the ready flow of ideas, and with the readiness to change the direction of one's responses.

By contrast, convergent semantic behavior involves the generation of an individual's highly organized systematically stored semantic knowledge. This behavior is concerned with the recognition or reproduction of already learned material, and the fitting of old semantic responses to new situations in a more or less mechanical way. (1976, p. 664)

Based on these definitions, it appears reasonable to hypothesize that divergent behavior is associated with a flexible hypothesis-testing or rule approach to learning. In contrast, the convergent thinker may be less likely to see all the response (rule) alternatives on a concept attainment task, because overlearned concepts and perceptually salient cues may tend to dominate thinking. Chapey *et al.* (1976) found aphasics to be impaired in their divergent abilities in the semantic verbal expressive realm. Future research could investigate the interaction of divergent/convergent behavior, cognitive tempo, and problem-solving ability, both verbal and nonverbal, and relate these findings to treatment outcomes.

Learning Potential

The definition of optimal teaching methods relative to cognitive style in adult aphasics is important to the broader issue of learning potential. The aphasiologist is interested in the variety of factors which allow him to prognosticate about the individual's ability to learn, and the specify the conditions in which learning can be maximized. One of the approaches to assessing learning potential is

to present a novel task and observe rate of learning, strategies employed, modality preferences, etc. Referring to a nonverbal problem-solving training method called the Raven Learning Potential Procedure (RLPP), Budoff and Corman (1976) suggested:

. . . the learning potential assessment approach is based on a conceptualization of intelligence which stresses trainability, or the ability to profit from learning experiences. (1976, p. 260)

Using stimuli of graded difficulty derived in concept from the RCFM, these researchers reported an increase in the ability to reason by analogy in retarded and nonretarded children. Corman and Budoff (1974) also developed a learning potential procedure called the Picture Word Game (PWG). This was used for assessing language-related symbol learning in low socioeconomic status children. The PWG required the association of geometric form symbols with pictures depicting common objects and actions with the goal of encoding and decoding sentences.

The important point is that learning potential assessment de-emphasizes "performance," which implies static and perhaps rote behavior in an artificial testing situation, and emphasizes "learning," an active, goal-oriented process. If the cognitive skills observed during training-oriented learning such as the RLPP and the PWG can be shown to generalize to more functional language behaviors, such procedures clearly would have prognostic value. A premise of the present study was that observation of learning performance within specified teaching conditions and with an appreciation for individual cognitive tempo differences could be valuable to the aphasiologist.

The findings of the present study confirm the need for further exploration of a learning potential approach to diagnosis and treatment of aphasia.

Suggestions for Further Research

Several areas of further research were suggested in the above discussion.

Most important, the efficacy of antecedent, consequent, and antecedent-plus-consequent teaching methodology for verbal learning should be investigated with respect to cognitive tempo characteristics of aphasic individuals. Careful consideration of complexity, concreteness and meaningfulness of verbal learning tasks would be essential. Similarly, the variety, modality and intensity of cues within each teaching method should be broadened and systematically manipulated.

To more fully understand the interaction of teaching methodology and aphasic disturbance, subject selection should be guided by the type and severity of aphasia as measured not only by multi-modality aphasia batteries such as the PICA, but also by more discrete evaluation of specific modalities and skills, especially auditory verbal comprehension.

The concern for a relationship among language, nonverbal reasoning ability and verbal learning potential may warrant subject selection based on the similar or disparate performance on language and intellectual measures. Using the PICA and the RCPM, for example, presumably four groups could be selected (high PICA-high RCPM;

low FICA-high RCPM; high FICA-low RCPM; low FICA-high RCPM). Careful subject selection using such a matrix in nonverbal and verbal learning experiments might help resolve this issue.

The potential importance of cognitive tempo characteristics for prognosis of language restitution in aphasics warrant the inclusion of cognitive style assessment procedures in longitudinal recovery studies.

The use of learning potential (training-based) assessment procedures should be more fully investigated as an aid for predicting success of aphasia treatment.

In this study, the small data base may have limited findings relative to the interaction of cognitive tempo and teaching method. Future research interested in such interactions should select subjects a priori on the basis of cognitive tempo classifications. Experimental consideration of such variables as central versus incidental learning, temporal characteristics, spectator versus participant roles, problem-solving strategies, rule learning ability, and convergent-divergent thinking as they relate to both cognitive style and teaching method also appears to be warranted.

Finally, if cognitive tempo is found to be a stable disposition that has predictive value and lends insight into selection of tasks and teaching methodology as the literature suggests, the efficacy of modifying cognitive tempo in order to optimize aphasia treatment should be studied.

Summary and Conclusions

The results of this study provided insight into the 3 main problem areas initially described.

First, the issue of the relative efficacy for aphasic individuals of 3 teaching methods contrasted in terms of selected antecedent and consequent procedures on a nonverbal rule learning task was studied. The 3 methods were: Method A (antecedent model), Method C (consequent corrective feedback) and Method AC (model and corrective feedback). The results of this study supported the conclusion that within each teaching method and in overall learning proficiency, the performance of LED aphasic subjects was not significantly different from RBD nonaphasic or NBD subjects.

Second, the relationship of nonverbal learning to language, immediate memory and abstract reasoning in aphasics was investigated. The LED aphasic group was significantly poorer than both RBD and NBD groups in language ability and immediate memory for digits, and significantly poorer than the NBD group in immediate memory for geometric forms. Visual abstract reasoning ability in the aphasic group was not significantly different from either control group. Consistent statistically significant correlations across subject groups among language, immediate memory, visual abstract reasoning and the dependent nonverbal learning measures were not obtained. Thus, the possible conclusion of predictable relationships between any one of these variables and nonverbal rule learning ability for any group of subjects was not supported.

Finally, the problem of defining cognitive tempo characteristics

of aphasic individuals was studied. The cognitive tempo composition for the 3 groups studied was identified. In the LBD aphasic group 5 subjects were reflective; 4, impulsive; and 3, neither. In the RBD group 3 subjects were reflective; 8, impulsive; and 1, neither. In the NBD group 4 subjects were reflective; 5, impulsive; and 3, neither. It appeared from these data that aphasics as a group were qualitatively different from RBD subjects, who as a group were more impulsive. In contrast, the LBD aphasic group appeared quite similar to the NBD subject group in that both groups included about equal numbers of reflective and impulsive individuals.

An analysis of the interaction of cognitive style and teaching method yielded to the most important finding of this study. When subjects from all groups were pooled, no difference between reflective and impulsive subjects relative to teaching method was observed. However, a statistically significant interaction between teaching method and cognitive style occurred for reflective LBD aphasics. For this subgroup, the modelling approach (Method A) effected significantly poorer performance than either the corrective feedback (Method C) or the modelling plus feedback (Method AC) teaching methods. No other cognitive style by method interactions yielded significant differences in nonverbal rule learning.









The contention of Winitz (1976) that teaching methodology should be compatible with learner variables gained support from the findings of this study. Furthermore, the findings relative to cognitive tempo suggest one way in which the process model of language deficit could be operationalized. The implications for further research included investigating the interaction of cognitive tempo in aphasics relative

to verbal as well as nonverbal learning, more refined manipulation of teaching methods using the antecedent-consequent distinction, as well as to other cognitive/intellectual performance variables. Finally, the findings of this study confirmed the need for further exploration of a learning potential approach to aphasia diagnosis and treatment. A more precise definition of "learner" variables in the adult aphasic individual will lend more precision to the clinical imperative of selecting optimal goals and tasks of treatment. The compatibility of the aphasic individual's cognitive tempo disposition and teaching methodology may be critical to his success and should not be left to chance.









APPENDICES

APPENDIX A
EXPERIMENTAL STIMULI
ARRANGED BY TYPE

TYPE 1









					
Size-small		1	2	3	4
Shading-plain		5	6	7	8
Border-single		9	10	11	12
		13	14	15	16

TYPE 2









					
Size-small		17	18	19	20
Shading-dotted		21	22	23	24
Border-single		25	26	27	28
		29	30	31	32

APPENDIX A - CONTINUED

TYPE 3









					
<u>TYPE 3</u>					
Size-small		33	34	35	36
Shading-plain		37	38	39	40
Border-double		41	42	43	44
		45	46	47	48

TYPE 4









TYPE 4					
Size-small		49	50	51	52
Shading-dotted		53	54	55	56
Border-double		57	58	59	60
		61	62	63	64

APPENDIX A - CONTINUED

TYPE 5Size-
largeShading-
plainBorder-
single









				
	65	66	67	68
	69	70	71	72
	73	74	75	76
	77	78	79	80

TYPE 6Size-
largeShading-
dottedBorder-
single









				
	81	82	83	84
	85	86	87	88
	89	90	91	92
	93	94	95	96

APPENDIX A - CONTINUED

TYPE 7

TYPE 7					
Size-large		97	98	99	100
Shading-plain		101	102	103	104
Border-double		105	106	107	108
		109	110	111	112

TYPE 8

<u>TYPE 8</u>					
Size-large		113	114	115	116
Shading-dotted		117	118	119	120
Border-double		121	122	123	124
		125	126	127	128

APPENDIX B
ORDER OF STIMULI
FOR TEACHING AND RESPONSE SETS

TEACHING SET

1.	62	21.	26
2.	47	22.	63
3.	81	23.	99
4.	84	24.	2
5.	59	25.	77
6.	8	26.	5
7.	117	27.	20
8.	9	28.	128
9.	31	29.	107
10.	25	30.	55
11.	41	31.	115
12.	72	32.	36
13.	29	33.	70
14.	91	34.	113
15.	119	35.	97
16.	80	36.	37
17.	98	37.	100
18.	39	38.	76
19.	95	39.	49
20.	83	40.	10

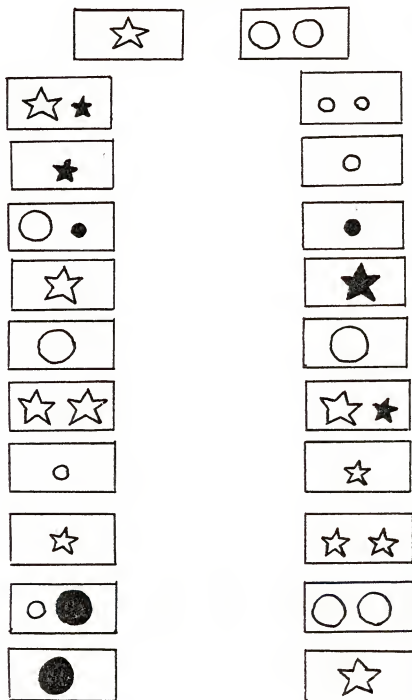
APPENDIX B - CONTINUED

RESPONSE SET

1. 53	21. 109	41. 66	61. 43
2. 73	22. 18	42. 13	62. 11
3. 32	23. 14	43. 125	63. 6
4. 127	24. 89	44. 123	64. 19
5. 54	25. 40	45. 46	65. 58
6. 42	26. 23	46. 68	66. 12
7. 90	27. 3	47. 82	67. 116
8. 21	28. 57	48. 16	68. 93
9. 87	29. 1	49. 50	69. 56
10. 75	30. 35	50. 22	70. 17
11. 122	31. 78	51. 4	71. 47
12. 69	32. 15	52. 28	72. 74
13. 34	33. 120	53. 67	73. 126
14. 71	34. 79	54. 44	74. 30
15. 92	35. 106	55. 94	75. 112
16. 86	36. 60	56. 85	76. 108
17. 96	37. 61	57. 103	77. 52
18. 24	38. 27	58. 65	78. 114
19. 33	39. 38	59. 64	79. 111
20. 45	40. 105	60. 7	80. 124

APPENDIX C
PRACTICE TASK STIMULI
ARRANGED BY ORDER OF PRESENTATION

Starter Cards



APPENDIX D
WISCONSIN CARD-SORTING TEST (WCST)
PROCEDURE
(Grant and Berg, 1948)

The materials consisted of a pack of four stimulus cards and 64 response cards which were devised so that each card contained from one to four identical figures of a single color. Four kinds of figures were used: stars, crosses, triangles, and circles. Four different colors were used: red, yellow, green, and blue. A single card might have four red stars, or two green circles, or any of the 64 possible combinations of colors, numbers, and forms. Each card could then be sorted or categorized according to the color, the number of the form of the figure. The four stimulus cards were: first, one red triangle; second, two green stars; third, three yellow crosses; and fourth, four blue circles.

The four stimulus cards were placed before the S from left to right in the order named. The S was given the pack of response cards and was instructed in the following manner: "I want you to put these cards into four groups, underneath the ones lying on the table. I will tell you whether you are "right" or "wrong."

The initial 'correct' sorting category was arbitrarily determined in advance to be color. As the S sorted the response cards he was informed whether he was "right" or "wrong." As soon as the S made a certain number of consecutive correct responses (reinforcing or confirming trials), the E shifted the problem with no explanation to S and began to call the number classifications "right" and all others, including color, "wrong." In this way, the "correct" classification or category was later shifted from number to form, then back to number, then to color, and finally to form. The S's only cue to the shifts was in the E's "rights" or "wrongs." If the S used the whole pack of cards before the six successive sorting categories were completed, the cards were reassembled and handed back to him. The cards were always presented in a standardized order so that no like form, color, or number followed each other. The experiment was considered completed after the S had finished the six categories or used more than 64 cards in a single category.

BIBLIOGRAPHY

- Adams, W.V. Strategy differences between reflective and impulsive children. Child Development, 1972, 43, 1076-1080.
- Andersen, A.L. The effect of laterality localization of focal brain lesions on the Wechsler-Bellevue subtests. Journal of Clinical Psychology, 1951, 7, 149-153.
- Archibald, Y.M., Wepman, J.M. & Jones, L.V. Nonverbal cognitive performance in aphasic and nonaphasic brain-damaged persons. Cortex, 1967, 3, 275-294.
- Arrigoni, G. & DeRenzi, E. Constructional apraxia and hemispheric locus of lesion. Cortex, 1964, 1, 180-197.
- Baird, R.R. & Bee, H.L. Modification of conceptual style preference by differential reinforcement. Child Development, 1969, 40, 903-910.
- Barton, M., Maruszewski, M. & Urrea, D. Variation of stimulus context and its effect on word-finding ability in aphasics. Cortex, 1969, 5, 351-364.
- Basso, A., DeRenzi, E., Faglioni, G., Scotti, G. & Spinnler, H. Neuropsychological evidence for the existence of cerebral areas critical to the performance of intelligence tasks. Brain, 1973, 96, 715-728.
- Bauer, R.W. & Becka, D.M. Intellect after cerebrovascular accident. Journal of Nervous and Mental Diseases, 1954, 120, 379-384.
- Becker, W.C., Engelmann, S. & Thomas, D.R. Teaching: A course in applied psychology. Chicago: Science Research Associations, 1971.
- Benton, A.L., Smith, K.C. & Lang, M. Stimulus characteristics and object naming in aphasic patients. Journal of Communication Disorders, 1972, 5, 19-24.
- Berman, M. & Peelle, L.M. Self-generated cues: A method for aiding aphasic and apractic patients. Journal of Speech and Hearing Disorders, 1967, 32, 372-376.

- Beyn, E.S. & Shokhar-Trotskaya, M.K. The preventive method of speech rehabilitation in aphasia. Cortex, 1966, 2, 96-108.
- Bollinger, R.L. & Stout, C.E. Response contingent small step treatment: Performance-based communication intervention. Journal of Speech and Hearing Disorders, 1976, 41, 40-52.
- Boone, D.R. Communication skills and intelligence in right and left hemiplegics. Journal of Speech and Hearing Disorders, 1959, 24, 241-248.
- Brewer, W.M. Visual memory, verbal encoding and hemispheric localization. Cortex, 1969, 5, 145-151.
- Brookshire, R.H. Effects of delay of reinforcement on probability learning by aphasic subjects. Journal of Speech and Hearing Research, 1971, 14, 92-105.
- Brookshire, R.H. Effects of task difficulty on naming performance of aphasic subjects. Journal of Speech and Hearing Research, 1972, 15, 551-558.
- Budoff, M. & Corman, L. Effectiveness of a learning potential procedure in improving problem-solving skills of retarded and non-retarded children. American Journal of Mental Deficiency, 1976, 81, 260-264.
- Campbell, S.B. Cognitive styles in reflective, impulsive and hyperactive boys and their mothers. Perceptual and Motor Skills, 1973, 36, 747-752.
- Carson, D.H., Carson, F.E. & Tikofsky, R.S. On learning characteristics of adult aphasics. Cortex, 1968, 4, 92-112.
- Chapey, R., Rigrodsky, S. & Morrison, E.B. Divergent semantic behavior in aphasia. Journal of Speech and Hearing Research, 1976, 19, 664-677.
- Cooperman, M.L. Field dependence and children's problem solving under varying contingencies of predetermined feedback (Doctoral dissertation, Fordham University, 1974). Dissertation Abstracts International, 1974, 35, 4243A.
- Corlew, M.M. & Nation, J.E. Characteristics of visual stimuli and naming performance in aphasic adults. Cortex, 1975, 11, 186-191.
- Corman, L. & Budoff, M. The picture word game: A nonverbal test of the ability to use language related symbols. Studies in Learning Potential, 1974, 4, 1-8.

- Costa, L.D. The relation of visuospatial dysfunction to digit span performance in patients with cerebral lesions. Cortex, 1975, 11, 31-36.
- Costa, L.D. & Vaughn, H.G. Performance of patients with lateralized cerebral lesions. I: Verbal and perceptual tests. Journal of Nervous and Mental Diseases, 1962, 134, 162-168.
- Costa, L.D., Vaughn, H.G., Horwitz, M. & Ritter, W. Patterns of behavioral deficit associated with visual spatial neglect. Cortex, 1969, 5, 242-263.
- Croskey, C.S. & Adams, M.R. A rationale and clinical methodology for selecting vocabulary stimulus material for individual aphasic patients. Journal of Communication Disorders, 1969, 2, 340-343.
- Culton, G.L. Spontaneous recovery from aphasia. Journal of Speech and Hearing Research, 1969, 12, 825-832.
- Davis, A.J. Cognitive styles: Methodological and developmental considerations. Child Development, 1971, 42, 1447-1459.
- Davis, A.J. Categorization styles in older children and adolescents. Journal of Youth and Adolescence, 1976, 5, 187-200.
- Davis, J.K. & Klausmeier, H.J. Cognitive style and concept identification as a function of complexity and training procedures. Journal of Educational Psychology, 1970, 61, 423-430.
- Denney, D.R. Modeling effects upon conceptual styles and cognitive tempo. Child Development, 1972, 43, 105-119.
- DeRenzi, E. & Faglioni, P. The comparative efficiency of intelligence and vigilance tests in detecting hemispheric cerebral damage. Cortex, 1965, 1, 410-429.
- DeRenzi, E., Faglioni, P., Savoiardo, M. & Vignolo, L.A. The influence of the hemispheric side of the cerebral lesion on abstract thinking. Cortex, 1966, 2, 399-420.
- DeRenzi, E. & Michelli, P. Verbal and nonverbal short term memory impairment following hemispheric damage. Cortex, 1975, 11, 341-354.
- Drake, D.M. Perceptual correlates of impulsive and reflective behavior. Developmental Psychology, 1970, 2, 202-214.
- Drewe, E.A. The effect of type and area of brain lesion on Wisconsin Card Sorting Test performance. Cortex, 1974, 10, 159-170.

- Dunn, L.M. Peabody Picture Vocabulary Test. Circle Pines, Minn.: American Guidance Service, 1959.
- Edwards, A.E. Automated training for a 'matching to sample' task in aphasia. Journal of Speech and Hearing Research, 1965, 8, 39-42.
- Ettlinger, G. & Moffett, A.M. Learning in dysphasia. Neuropsychologia, 1970, 8, 465-474.
- Ettlinger, G., Teuber, H. & Milner, B. The seventeenth international symposium of neuropsychology. Neuropsychologia, 1975, 13, 131.
- Filby, Y. & Edwards, A.E. An application of automated teaching methods to test and teach form discrimination to aphasics. Journal of Programmed Instruction, 1963, 2, 25-33.
- Fowler, R.S. & Fordyce, W.E. Stroke: Why do they behave that way? Seattle: Washington State Heart Association, 1974.
- Fox, D.C. The effects of cognitive style on immediate memory span with differing input modalities (Doctoral dissertation, University of Denver, 1974). Dissertation Abstracts International, 1974, 35, 6361A.
- Gaines, R. Developmental perception and cognitive styles: From young children to master artists. Perceptual and Motor Skills, 1975, 40, 983-998.
- Cardiner, B.J. & Brookshire, R.H. Effects of unisensory and multi-sensory presentation of stimuli upon naming by aphasic subjects. Language and Speech, 1972, 15, 342-357.
- Glass, A.V., Gazzaniga, M.S. & Premack, D. Artificial language training in global aphasics. Neuropsychologia, 1973, 11, 95-103.
- Goodenough, D.R. The role of individual differences in field dependence as a factor in learning and memory. Psychological Bulletin, 1976, 83, 675-694.
- Goodglass, H., Barton, M.I. & Kaplan, E.F. Sensory modality and object-naming in aphasia. Journal of Speech and Hearing Research, 1968, 11, 488-496.
- Goodkin, R. Case studies in behavioral research in rehabilitation. Perceptual and Motor Skills, 1966, 22, 171-182.
- Goodkin, R. Changes in word production, sentence production and relevance in an aphasic through verbal conditioning. Behavior Research and Therapy, 1969, 7, 93-99.

- Grant, D.A. Test manual for the Wisconsin Card-Sorting Task.
Madison: University of Wisconsin, 1954.
- Grant, D.A. & Berg, E.A. A behavioral analysis of degree of reinforcement and ease of shifting to new responses in a Weigl-type card-sorting problem. Journal of Experimental Psychology, 1948, 38, 404-411.
- Guilford, J.P. The nature of human intelligence. New York: McGraw-Hill, 1967.
- Halberstam, J.L. & Zaretsky, H.H. Learning capacities of the elderly and brain-damaged. Archives of Physical Medicine and Rehabilitation, 1969, 50, 133-139.
- Halpern, H. Effect of stimulus variables on verbal perseveration of dysphasic speech. Perceptual and Motor Skills, 1965, 20, 421-429.
- Hedrick, D.L., Christman, M.A. & Augustine, L. Programming for the antecedent event in therapy. Journal of Speech and Hearing Disorders, 1973, 38, 339-342.
- Heilbrun, A.B. Psychological test performance as a function of lateralization of cerebral lesion. Journal of Comparative & Physiological Psychology, 1956, 49, 10-14.
- Holland, A. Case studies in aphasia rehabilitation. Journal of Speech and Hearing Disorders, 1972, 37, 3-21.
- Kagan, J. Reflection-impulsivity and reading ability in primary grade children. Child Development, 1965, 36, 609-628.
- Kagan, J. Reflection-impulsivity: The generality and dynamics of conceptual tempo. Journal of Abnormal Psychology, 1966, 71, 12-24. (a)
- Kagan, J. Body build and conceptual impulsivity in children. Journal of Personality, 1966, 34, 118-128. (b)
- Kagan, J. & Kogan, N. Individual variation in cognitive processes. In P. Mussen (Ed.), Carmichael's manual of child psychology (3rd ed., Vol. 1). New York: Wiley, 1970.

- Kagan, J., Moss, H. & Sigel, I. Psychological significance of styles of conceptualization. Monographs of the Society for Research in Child Development, 1963, 28, 73-112.
- Kagan, J., Pearson, L. & Welch, L. Conceptual impulsivity and inductive reasoning. Child Development, 1966, 37, 583-594. (a)
- Kagan, J., Pearson, L. & Welch, L. The modifiability of an impulsive tempo. Journal of Educational Psychology, 1966, 57, 359-365. (b)
- Kagan, J., Rosman, B., Day, D., Albert, J. & Phillips, W. Information processing in the child: Significance of analytic and reflective attitudes. Psychological Monographs, 1964, 78, No. 1 (whole no. 578).
- Katz, L. Learning in aphasic patients. Journal of Consulting Psychology, 1958, 22, 143-146.
- Keenan, J.S. & Brassell, E.G. Aphasia Language Performance Scales. Murfreesboro, Tenn.: Pinnacle Press, 1975.
- Kertesz, A. & McCabe, P. Intelligence and aphasia: Performance of aphasics on Raven's Coloured Progressive Matrices (RCPM). Brain and Language, 1975, 2, 387-395.
- Kertesz, A. & Poole, E. The aphasia quotient: The taxonomic measurement of aphasic disability. Canadian Journal of Neurological Science, 1974, 1, 7-17.
- Kim, Y.C. Deficits in temporal sequencing of verbal material: The effect of laterality of lesion. Brain and Language, 1976, 3, 507-515.
- Kim, Y.C., Boller, F., Mack, J.L. & Vrtunski, P.B. The effect of language dysfunction on simple conceptual tasks. Paper presented at the Academy of Aphasia, Miami, Florida, October, 1976.
- Kushner, H., Hubbard, D.J. & Knox, A.W. Effects of punishment on learning by aphasic subjects. Perceptual and Motor Skills, 1973, 36, 283-289.
- LaPointe, L.L. The treatment of behavioral disturbances in adults: Current trends and a few reasons for optimism in clinical aphasiology. Paper presented at the meeting of the Florida Society of Neurology, Orlando, Florida, December, 1975.
- LaPointe, L.L. Aphasia therapy: Some principles and strategies for treatment of the person with aphasia. In D.F. Johns (Ed.), Communicative disorders related to neurological problems. Boston: Little, Brown & Co., 1977, in press.

- LaPointe, L.L. & Horner, J. Repeated trials of words by patients with neurogenic phonological selection-sequencing impairment (apraxia of speech): Stimulus mode and response condition revisited. In R.H. Brookshire (Ed.), Clinical aphasiology conference: Proceedings. Minneapolis: BRK Publishers, 1976.
- LaPointe, L.L. & Williams, W.N. Recognition of geometric shapes by unimodal and simultaneous multimodal presentation in aphasics. Paper presented at the meeting of the American Speech and Hearing Association, Chicago, 1971.
- Lebrun, Y. & Hoops, R. Intelligence and aphasia. Amsterdam: Swets & Zeitlinger B.V., 1974.
- Lenne, M.L., Wertz, R.T. & Rosenbek, J.C. The effects of stimulus modality on verbal output in brain-injured adults. Paper presented at the meeting of the American Speech and Hearing Association, Las Vegas, 1974.
- Marshall, R.C. Treatment approaches in adult aphasia. Paper presented at the 3rd Conference of Clinical Aphasiology, Albuquerque, 1973.
- Martin, A.C. A critical evaluation of therapeutic approaches to aphasia. In R.H. Brookshire (Ed.), Clinical aphasiology conference: Proceedings. Minneapolis: BRK Publishers, 1975.
- McDearmon, J.R. & Potter, R.E. The use of representational prompts in aphasia therapy. Journal of Communication Disorders, 1975, 8, 199-206.
- McFie, J. & Piercy, M.F. The relation of laterality of lesions to performance on Weigl's Sorting Test. Journal of Mental Science, 1952, 98, 299-308.
- McFie, J. & Zangwill, O.L. Visual-constructive disabilities associated with lesions of the left cerebral hemisphere. Brain, 1960, 83, 243-260.
- McKinney, J.D. Problem-solving strategies in impulsive and reflective second graders. Developmental Psychology, 1973, 8, 145.
- Messer, S.B. Reflection-impulsivity: A review. Psychological Bulletin, 1976, 83, 695-715.
- Meyers, R. Relation of 'thinking' and language. Archives of Neurology, 1948, 60, 119-139.
- Milner, B. Effects of different brain lesions on card sorting. Archives of Neurology, 1963, 9, 90-99.

- Montgomery, J.H. The effects of feedback and consequentiality on the cognitive style dimensions of reflection-impulsivity (Doctoral dissertation, University of South Carolina, 1974). Dissertation Abstracts International, 1974, 35, 6124B.
- Moscovitch, M. On the representation of language in the right hemisphere of right handed people. Brain and Language, 1976, 3, 47-71.
- Muma, J.R. New perspectives in clinical assessment: Cognitive, linguistic communicative systems. Paper presented at George Washington University, Washington, D.C., 1977.
- Nebelkopf, E.B. & Dreyer, A.S. Continuous-discontinuous concept attainment as a function of individual differences in cognitive style. Perceptual and Motor Skills, 1973, 36, 655-662.
- Neisser, U. Cognitive psychology. New York: Appleton-Century-Crofts, 1966.
- Nelson, H.E. A modified card sorting test sensitive to frontal lobe deficits. Cortex, 1976, 12, 313-324.
- Nuessle, W. Reflectivity as an influence on focusing behavior of children. Journal of Experimental Child Psychology, 1972, 14, 265-276.
- Odom, R.D., McIntyre, C.W. & Neale, G.S. The influence of cognitive style on perceptual learning. Child Development, 1971, 42, 883-891.
- Parisi, D. & Pizzamiglio, L. Syntactic comprehension in aphasia. Cortex, 1970, 6, 204-215.
- Piercy, M. & Smyth, V.O.G. Right hemisphere dominance for certain non-verbal intellectual skills. Brain, 1962, 85, 775-790.
- Poppen, R.L., Pribram, K.H. & Robinson, R.S. Effects of frontal lobotomy in man on the performance of a multiple choice task. Experimental Neurology, 1965, 11, 217-229.
- Porch, B.E. Porch Index of Communicative Ability. Palo Alto: Consulting Psychologists Press, 1967.
- Premack, D. Language in chimpanzee. Science, N.Y., 1971, 172, 808-822.
- Raven, J.C. The Coloured Progressive Matrices. Los Angeles: Western Psychological Services, 1965.
- Reitan, R.M. Intelligence and language functions in dysphasic patients. Diseases of the Nervous System, 1954, 15, 2-8.

- Reitan, R.M. Certain differential effects of left and right cerebral lesions in human adults. Journal of Comparative & Physiological Psychology, 1955, 48, 474-477.
- Rosenbek, J.C., Lemme, M.L., Ahern, M.B., Harris, E. & Wertz, R.T. Treatment of apraxia of speech in adults. Journal of Speech and Hearing Disorders, 1973, 38, 462-472.
- Rosenberg, B. The performance of aphasics on automated visuo-perceptual discrimination training and transfer tasks. Journal of Speech and Hearing Research, 1965, 8, 165-181.
- Rosenberg, B. & Edwards, A.E. The performance of aphasics on three automated perceptual discrimination programs. Journal of Speech and Hearing Research, 1964, 7, 295-298.
- Schuell, H.M. Minnesota Test for Differential Diagnosis of Aphasia. Minneapolis: University of Minnesota, 1966.
- Schuell, H., Jenkins, J. & Jimenez-Pabon, E. Aphasia in adults. New York: Hoeber Medical Division, Harper & Row, 1964.
- Shewan, G.M. & Canter, G.J. Effects of vocabulary, syntax and sentence length on auditory comprehension in aphasic patients. Cortex, 1971, 7, 209-226.
- Shontz, F.C. Evaluation of intellectual potential in hemiplegic individuals. Journal of Clinical Psychology, 1957, 13, 267-269.
- Sulzer, B. & Mayer, G.R. Behavior modification procedures for school personnel. Hinsdale, Ill.: The Dryden Press, 1972.
- Taylor, M. Language therapy. In H. Burr (Ed.), The aphasic adult: Evaluation and rehabilitation. Charlottesville: Wayside Press, 1963.
- Teuber, H.L., Battersby, W.S. & Bender, M.B. Performance of complex visual tasks after cerebral lesions. Journal of Nervous and Mental Diseases, 1951, 114, 413-429.
- Tikofsky, R.S. Two studies of verbal learning by adult aphasics. Cortex, 1971, 7, 106-125.
- Tikofsky, R.S. & Reynolds, G.L. Preliminary study: Nonverbal learning and aphasia. Journal of Speech and Hearing Research, 1962, 5, 135-143.
- Tikofsky, R.S. & Reynolds, G.L. Further studies of nonverbal learning and aphasia. Journal of Speech and Hearing Research, 1963, 6, 329-337.

- Ulatowska, H.K. & Richardson, S.M. A longitudinal study of an adult with aphasia: Considerations for research and therapy. Brain and Language, 1974, 1, 151-166.
- Webb, W.G. & Love, R.J. The efficacy of cueing techniques with apraxic-aphasics. Paper presented at the meeting of the American Speech and Hearing Association, Las Vegas, 1974.
- Weigl, E. On the psychology of so-called processes of abstraction. Journal of Abnormal Social Psychology, 1941, 36, 3-33.
- Weigl, E. Neuropsychological experiments on transcoding between spoken and written language structures. Brain and Language, 1974, 1, 227-238.
- Weigl, E. & Bierwisch, M. Neuropsychology and linguistics: Topics of common research. Foundations of Language, 1970, 6, 1-18.
- Weiner, A.S. & Berzonsky, M.D. Development of selective attention in reflective and impulsive children. Child Development, 1975, 46, 545-549.
- Weisenburg, T. & McBride, K.E. Aphasia: A clinical and psychological study. New York: Commonwealth Fund, 1935.
- Wepman, J.M. Aphasia therapy: A new look. Journal of Speech and Hearing Disorders, 1972, 37, 203-214.
- Wepman, J.M. & Jones, L.V. The Language Modalities Test for Aphasia. Chicago: Education-Industry Service, 1961.
- Wertz, R.T. The effects of interhemispheric and intrahemispheric lesions on nonverbal trial-and-error learning behavior in brain-damaged adults (Doctoral dissertation, Stanford University, 1967). Dissertation Abstracts International, 1967.
- Whitney, J.L. Developing aphasics' use of compensatory strategies. Paper presented at the meeting of the American Speech and Hearing Association, Washington, D.C., 1975.
- Winitz, H. Dimensions of articulation training. In L.J. Bradford (Ed.), Communicative disorders: An audio journal for continuing education. New York: Grune & Stratton, Inc., 1976.
- Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R. & Karp, S.A. Psychological differentiation, studies of development. New York: John Wiley & Sons, Inc., 1962.

Wolking, W.D. Some general suggestions for designing the conditions of instruction (manipulating the components of the behavior equation). Manuscript, University of Florida, 1974.

Zangwill, O.L. Intelligence in aphasia. In A.V.S. DeReuck & M. O'Connor (Eds.), Disorders of language. Boston: Little, Brown, 1964.

Zelniker, T., Jeffrey, W.E., Ault, R. & Parsons, J. Analysis and modification of search strategies of impulsive and reflective children on the Matching Familiar Figures test. Child Development, 1972, 43, 321-335.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.



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